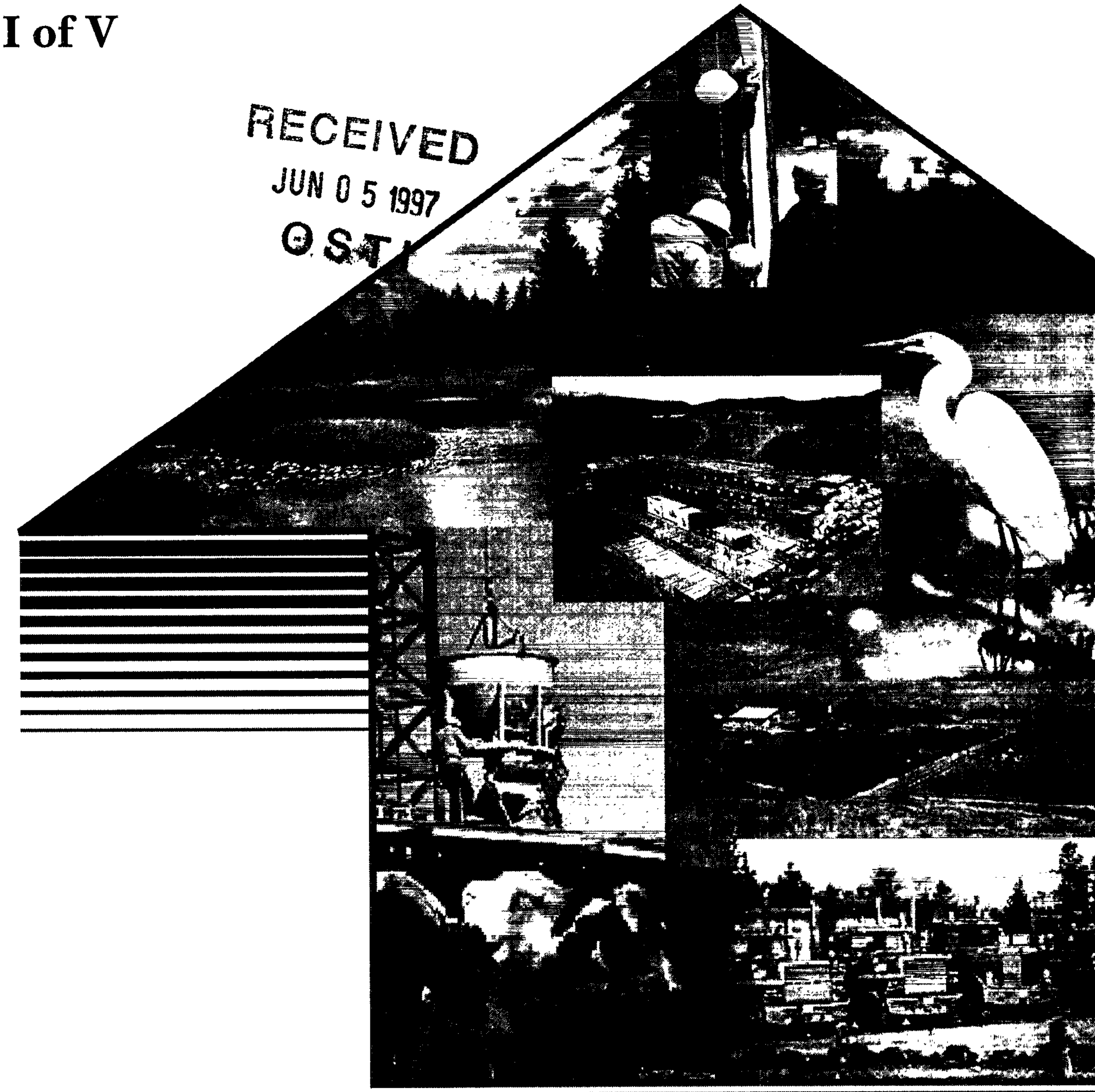
U.S. Department of Energy
Office of Environmental Management

Final Waste Management Programmatic Environmental Impact Statement

For Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

DOE/EIS-0200-F-Vol. 1

Volume I of V



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Vol. I

FINAL
WASTE MANAGEMENT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
for
Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

Volume I of V

Chapters 1-15

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Office of Environmental Management
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COVER SHEET

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Abstract:

The Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) examines the potential environmental and cost impacts of strategic management alternatives for managing five types of radioactive and hazardous wastes that have resulted and will continue to result from nuclear defense and research activities at a variety of sites around the United States. The five waste types are low-level mixed waste, low-level waste, transuranic waste, high-level waste, and hazardous waste. The WM PEIS provides information on the impacts of various siting alternatives which the Department of Energy (DOE) will use to decide at which sites to locate additional treatment, storage, and disposal capacity for each waste type. This information includes the cumulative impacts of combining future siting configurations for the five waste types and the collective impacts of other past, present, and reasonably foreseeable future activities.

The selected waste management facilities being considered for these different waste types are treatment and disposal facilities for low-level mixed waste; treatment and disposal facilities for low-level waste; treatment and storage facilities for transuranic waste in the event that treatment is required before disposal; storage facilities for treated (vitrified) high-level waste canisters; and treatment of nonwastewater hazardous waste by DOE and commercial vendors. In addition to the no action alternative, which includes only existing or approved waste management facilities, the alternatives for each of the waste type configurations include decentralized, regionalized, and centralized alternatives for using existing and operating new waste management facilities. However, the siting, construction and operations of any new facility at a selected site will not be decided until completion of a sitewide or project-specific environmental impact review.

Reader's Guide

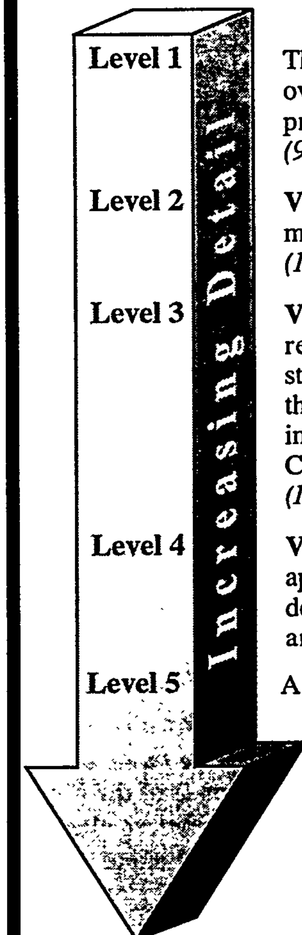
What is the purpose of this environmental impact statement?

The purpose of all environmental impact statements is to inform the public and decision makers of the potential impacts of proposed Federal actions and to identify which of these impacts might be significant to human health or the environment. In brief, the **Waste Management Programmatic Environmental Impact Statement (WM PEIS)** evaluates the possible impacts of several strategic waste management alternatives being considered by the U.S. Department of Energy (DOE).

How is it organized?

Chapter 1 of Volume I describes how the WM PEIS is organized. Recognizing that the public has varying levels of interest, the WM PEIS is separated into distinct levels that increase in complexity from the Summary to the technical reports. These levels are shown in the box at right.

Levels of Detail in the WM PEIS



Level 1 The **SUMMARY** contains an overview of all of the material presented in the WM PEIS. *(9 sections)*

Level 2 **VOLUME I** contains the main text of the document. *(15 chapters)*

Level 3 **VOLUME II** presents the results of the analytical studies, by site, that constitute the basis of the environmental impact discussions provided in Chapters 6–10 of Volume I. *(18 chapters)*

Level 4 **VOLUMES III AND IV** are appendices that provide more detail concerning the analyses and results. *(9 appendices)*

Level 5 A series of **TECHNICAL REPORTS** (available in the DOE reading rooms listed in Chapter 1 of Volume I) contains detailed information of interest to technical experts. *(32 reports)*

VOLUME V contains an indexed compilation of the public's comments on the draft WM PEIS and DOE's responses to them. All comments received during the public comment period were carefully considered.

How can I tell where the final document has been changed?

All text changes that have occurred since publication of the Draft WM PEIS are indicated with shading for tables and marginal rules for text. One exception is Appendix I, which is completely new.

What if I don't understand a term or an abbreviation?

The glossary in Chapter 14 of Volume I contains definitions of technical and less commonly used words. Some definitions can also be found in the main text of the document. Acronym lists spelling out the abbreviations used in the WM PEIS and its appendices are provided in the front of the document (the Summary and Volume I) and before each appendix.

Where can I find out what proposed Federal actions are evaluated in the WM PEIS?

DOE evaluates several possible alternatives for treatment, storage, or disposal of five types of waste generated from nuclear weapons production and related activities. The alternatives considered for each waste type are introduced in Chapter 1 of Volume I, and summarized in Section 1 of the Summary. Chapter 2 of Volume I discusses why DOE needs to make waste management decisions.

Where does DOE define the five waste types?

Definitions for the waste types are found in Section 1.5 of Volume I and Section 1.3 of the Summary.

Where are the waste management alternatives described?

Chapter 3 of Volume I and Section 2 of the Summary describe the alternatives for each type of waste and the methods used to develop the alternatives.

How did DOE decide which of its sites to include in the various alternatives?

Chapter 1 of Volume I introduces the basic rationale for identifying 17 DOE sites as the "major" sites in the waste management complex. Chapters 6–10 of Volume I present the rationale for determining which of these sites are included in each alternative for each waste type. Sections 2 and 4–8 of the Summary also contain this information.

Does DOE have preferred alternatives? Where can I find them discussed?

Yes, DOE has preferred alternatives for each of the five waste types. These alternatives are described in Chapter 3 of Volume I and in Section 2 of the Summary. The criteria used to select the preferred alternatives are presented in Chapter 1 of Volume I and Section 2 of the Summary.

How can I find out quickly and easily which alternatives were considered for each waste type?

An "At a Glance" page for each waste type summarizes the waste management alternatives (including DOE's preferred alternative) considered for that waste type. The data and assumptions used to compare the alternatives and the highlights of what was learned are also provided. The "At a Glance" pages can be found at the beginning of each waste type section in the Summary (Sections 4–8).

Where can I find more details about the possible impacts at a site?

More detailed information about possible impacts is provided in Volume II, where site-specific modeling results for health risks, air quality, water resources, socioeconomic impacts, and costs are presented. Also note that the maps in Appendix C (Volume III) depict minority and low-income population distributions for the major waste management sites. The table at the end of this guide shows where to find all of this information for each of the major sites.

What can DOE do about the possible impacts at a site?

Chapter 12 of Volume I describes the "mitigation measures" that DOE can use to reduce or eliminate potential impacts wherever appropriate. These measures are described on both a programmatic and a site level.

Where can I find information about a site near me?

The WM PEIS is a *programmatic* (i.e., Department-wide) study to evaluate strategies for managing waste. It is not a site-specific review. However, two chapters of Volume I are organized by site: Chapter 4, *Affected Environment*, and Chapter 11, *Cumulative Impacts*. Refer to the table at the end of this guide to find the sections of these chapters that discuss the site you are interested in.

Chapters 6–10 provide information in tables organized by site. A foldout table is included at the end of each of these chapters to use as a handy reference while you are reading the chapter. The foldout tables provide the waste management activities analyzed for each site under each alternative.

At the end of the Summary, a profile of each "major" site summarizes the amount of each type of waste at the site and the waste management alternatives considered for the site. The possible human health and environmental impacts of the preferred alternatives at the site are also briefly identified.

Guide to Finding Site Information in the WM PEIS

	Topic and WM PEIS Volume Number				
	Affected Environment	Cumulative Impacts	Site Data Tables	Distribution of Minority Populations (and Tribal Lands)	Distribution of Low-Income Populations
DOE Site	Volume I	Volume I	Volume II	Volume III	Volume III
ANL-E	Section 4.4.1	Section 11.3	Chapter II.2	Figure C.4-7	Figure C.4-24
BNL	Section 4.4.2	Section 11.4	Chapter II.3	Figure C.4-8	Figure C.4-25
FEMP	Section 4.4.3	Section 11.5	Chapter II.4	Figure C.4-9	Figure C.4-26
Hanford	Section 4.4.4	Section 11.6	Chapter II.5	Figure C.4-10a,b	Figure C.4-27
INEL	Section 4.4.5	Section 11.7	Chapter II.6	Figure C.4-11a,b	Figure C.4-28
LANL	Section 4.4.7	Section 11.9	Chapter II.7	Figure C.4-13a,b	Figure C.4-30
LLNL	Section 4.4.6	Section 11.8	Chapter II.8	Figure C.4-12	Figure C.4-29
NTS	Section 4.4.8	Section 11.10	Chapter II.9	Figure C.4-14	Figure C.4-31
ORR	Section 4.4.9	Section 11.11	Chapter II.10	Figure C.4-15	Figure C.4-32
Pantex	Section 4.4.11	Section 11.13	Chapter II.12	Figure C.4-17	Figure C.4-34
PGDP	Section 4.4.10	Section 11.12	Chapter II.11	Figure C.4-16	Figure C.4-33
PORTS	Section 4.4.12	Section 11.14	Chapter II.13	Figure C.4-18	Figure C.4-35
RFETS	Section 4.4.13	Section 11.15	Chapter II.14	Figure C.4-19	Figure C.4-36
SNL-NM	Section 4.4.14	Section 11.16	Chapter II.15	Figure C.4-20a,b	Figure C.4-37
SRS	Section 4.4.15	Section 11.17	Chapter II.16	Figure C.4-21	Figure C.4-38
WIPP	Section 4.4.16	Section 11.18	Chapter II.17	Figure C.4-22	Figure C.4-39
WVDP	Section 4.4.17	Section 11.19	Chapter II.18	Figure C.4-23a,b	Figure C.4-40

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Acronyms and Abbreviations

AI	Atomics International
Ames	Ames Laboratory
AMRC	Albany Metallurgical Research Center
ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
ARAM	Automated Remedial Action Methodology
ARARs	Applicable or Relevant and Appropriate Requirements
AEA	Atomic Energy Act
BEA	Bureau of Economic Analysis
BCL	Battelle Columbus Laboratory
BEMR	Baseline Environmental Management Report
Bettis	Bettis Atomic Power Laboratory
BGV	below-ground vault
BNL	Brookhaven National Laboratory
BRC	Below Regulatory Concern
CAA	Clean Air Act
CEER	Center for Energy and Environmental Research
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH	Contact-handled
Charleston	Charleston Naval Shipyard
CISS	Colonie Interim Storage Site
CWA	Clean Water Act
CY	Calendar Year
D&D	Decontamination and Decommissioning
DNFSB	Defense Nuclear Facilities Safety Board
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DP	Defense Programs
DUST	Disposal Unit Source Term
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
EDE	Effective Dose Equivalent
EH	DOE Office of Environment, Safety, and Health
EIS	Environmental Impact Statement
EM	Office of Environmental Management
EMAB	Environmental Management Advisory Board
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration

ETEC	Energy Technology Engineering Center
et seq.	and that which follows
FEMA	U.S. Federal Emergency Management Agency
FEMP	Fernald Environmental Management Project
Fermi	Fermi National Accelerator Laboratory
FFCAct	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
FR	Federal Register
FTE	Full-time Equivalent
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	Fiscal Year
GA	General Atomics
GCR	General Conformity Rule
GE	General Electric Vallecitos Nuclear Center
GJPO	Grand Junction Projects Office
GTCC	Greater-Than-Class C
Hallam	Hallam Nuclear Power Facility
Hanford	Hanford Site
HAPs	Hazardous Air Pollutants
HEPA	High Efficiency Particulate Air
HHS	U.S. Department of Health and Human Services
HLW	High-Level Waste
HW	Hazardous Waste
ICF	Inertial Confinement Fusion
ICPP	Idaho Chemical Processing Plant
IDHL	Immediately Dangerous to Life and Health
INEL	Idaho National Engineering Laboratory
IP	Implementation Plan
ITRI	Inhalation Toxicology Research Institute
K–25	Oak Ridge K-25 Site
KAFB	Kirtland Air Force Base
KAPL	Knolls Atomic Power Laboratory
KAPL-K	Knolls Atomic Power Laboratory-Kesselring
KAPL-N	Knolls Atomic Power Laboratory-Niskayuna
KAPL-W	Knolls Atomic Power Laboratory-Windsor
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LDRs	Land Disposal Restrictions
LEHR	Laboratory for Energy-Related Health Research
LLMW	Low-Level Mixed Waste

LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level Waste
m^3	cubic meter (1 cubic meter is equal to 35.314 cubic feet, or 264,173 gallons)
Mare Is	Mare Island Naval Shipyard
MISS	Maywood Interim Storage Site
MCL	Maximum Contaminant Level
MEI	Maximally Exposed Individual
MEPAS	Multimedia Environmental Pollutant Assessment System
Middlesex	Middlesex Sampling Plant
Mound	Mound Plant
MWIR	Mixed Waste Inventory Report
NAAQS	National Ambient Air Quality Standards
nCi/g	nanocuries per gram
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NOI	Notice of Intent
Norfolk	Norfolk Naval Shipyard
NRC	U.S. Nuclear Regulatory Commission
NRF	Naval Reactor Facility
NRHP	National Register of Historic Places
NHL	National Historic Landmark
NTS	Nevada Test Site
NWPA	Nuclear Waste Policy Act
ODS	Ozone-Depleting Substance
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Act
Paducah	Paducah Gaseous Diffusion Plant
PA/SI	Preliminary Assessment and Site Investigation
Palos	Palos Forest
Pantex	Pantex Plant
PCBs	Polychlorinated Biphenyls
PEIS	Programmatic Environmental Impact Statement
Pearl H	Pearl Harbor Naval Shipyard
PGDP	Paducah Gaseous Diffusion Plant
Pinellas	Pinellas Plant
PM_{10}	Particulate matter of aerodynamic diameter equal to or less than 10 micrometers
PNNL	Batelle Pacific Northwest National Laboratory
PORTS	Portsmouth Gaseous Diffusion Plant
Ports Nav	Portsmouth Naval Shipyard
PPPL	Princeton Plasma Physics Laboratory

PSD	Prevention of Significant Deterioration
Puget So	Puget Sound Naval Shipyard
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RH	Remote-handled
RI/FS	Remedial Investigation/Feasibility Study
RIMS	Regional Input-Output Modeling System
RMI	RMI Titanium Company
ROD	Record of Decision
ROI	Region of Influence
Salton Sea	Salton Sea Test Base
SARA	Superfund Amendment Reauthorization Act
SARs	Safety Analysis Reports
SDWA	Safe Drinking Water Act
SIW	Sanitary and Industrial Waste
SLAC	Stanford Linear Accelerator Center
SMAC	Shipment/Mobility Accountability Collection
SNF	Spent Nuclear Fuel
SNM	Special Nuclear Material
SNL-CA	Sandia National Laboratories (California)
SNL-NM	Sandia National Laboratories (New Mexico)
SRS	Savannah River Site
STPs	Site Treatment Plans
TAPs	Toxic Air Pollutants
TBE	Teledyne Brown Engineering
TCLP	Toxicity Characteristic Leaching Procedure
TEDE	Total Effective Dose Equivalent
TRUW	Transuranic Waste
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage, and Disposal
U of MO	University of Missouri
UMTRA	Uranium Mill Tailings Remedial Action Project
USAMC	U.S. Army Material Command
USC	U.S. Code
VOCs	Volatile Organic Compounds
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WIPP LWA	Waste Isolation Pilot Plant Land Withdrawal Act
WIPP-WAC	Waste Isolation Pilot Plant Waste Acceptance Criteria
WM PEIS	Waste Management Programmatic Environmental Impact Statement

WNYNSC	Western New York Nuclear Service Center
WSSR	Weldon Spring Remedial Action Project
WVDP	West Valley Demonstration Project
Y-12	Oak Ridge Y-12 Plant

CHAPTER 1
Introduction and Background

This chapter describes the U.S. Department of Energy's (DOE's) past and ongoing activities that generate and have resulted in the accumulation of wastes, and provides information about the statutory and regulatory framework under which DOE must operate to manage five types of waste. These waste types are defined, the involved DOE sites are identified, and the decisions that DOE must make with respect to managing those wastes are described. This chapter also includes a discussion of the relationship of this decision-making process to other DOE National Environmental Policy Act (NEPA) documents and programs.

1.1 Purpose of the Waste Management Programmatic Environmental Impact Statement

This Waste Management Programmatic Environmental Impact Statement (WM PEIS) is a nationwide study examining the environmental impacts of managing more than 2 million cubic meters of radioactive and hazardous wastes from past and future DOE activities. The WM PEIS will assist the U.S. Department of Energy (DOE) in improving the efficiency and reliability of managing its current and anticipated volumes of radioactive and hazardous wastes, will help DOE continue to comply with applicable laws and regulations, and will promote the protection of workers, public health and safety, and the environment (DOE, 1994b). The WM PEIS allows the public and DOE decision makers to make comparisons of the impacts from various potential configurations for the management of DOE wastes. The goal is a nationwide strategy to treat wastes in a safe, responsible, and efficient manner that minimizes impacts. Nevertheless, there will always be legitimate questions regarding waste management activities at certain sites. DOE understands and appreciates these concerns and will carefully consider them in making these strategic decisions.

Wastes analyzed in the WM PEIS result primarily from nuclear weapons production and related activities.[1] Wastes produced from nuclear weapons production and related activities are categorized into five waste types. These are: low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), high-level waste (HLW), and hazardous waste (HW). More information on the scope of this document and its relationship to other actions and programs can be found in Sections 1.7 and 1.8.

[1] Environmental restoration (ER), another activity resulting in waste generation, is reviewed but not analyzed in the WM PEIS.

Definitions of Wastes Analyzed in the WM PEIS:

- **Low-level mixed waste.** Waste that contains both hazardous waste under the Resource Conservation and Recovery Act (RCRA) and source, special nuclear, or by-product material subject to the Atomic Energy Act (AEA) of 1954 (42 USC 2011, *et seq.*).
- **Low-level waste.** Waste that contains radioactivity and is not classified as HLW, TRUW, or spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section 11(e)(2) of the Atomic Energy Act). Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as LLW, provided that the concentration of transuranic is less than 100 nCi/g.

Terms of Radioactivity

The spontaneous decay of unstable nuclei in the atom causes the release of particles or electromagnetic waves. These releases are measured in terms of the number of nuclear disintegrations per unit of time. The common unit for this is the "curie," which is 37 billion disintegrations per second. A ***nanocurie****, or one-billionth of a curie, designated as "nCi," is 37 disintegrations per second. The activity level of radiation, measured in curies, declines over time. The time it takes for the activity to drop to one-half of its starting value is known as the* ***half-life*** *of the material. DOE waste has half-lives as short as minutes in the case of some fission products (smaller atoms left over by the splitting of uranium and plutonium) to billions of years in the case of uranium-238 (one of two main isotopes of uranium).*

The dosage of radiation a person receives is measured in ***REMs*** *(roentgen equivalent man) and is typically stated in terms of thousandths of REMs (1/1,000 REM or millirem [mrem]).*

- **Transuranic wastes.** Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, with half-lives greater than 20 years, per gram of waste, and an atomic number greater than 92 except for (a) HLW, (b) waste that DOE has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency (EPA), does not need the degree of isolation required by 40 CFR 191, or (c) waste that the U.S. Nuclear Regulatory Commission (NRC) has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.
- **High-level waste.** The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include other highly radioactive material that the NRC, consistent with existing law, determines by rule requires permanent isolation.
- **Hazardous waste.** Under RCRA, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly

contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the AEA, are specifically excluded from the definition of solid waste.

Waste management is broadly defined as the treatment, storage, or disposal of waste. The activities associated with the management of the waste include:

- Pollution prevention
- Identifying and contracting with private vendors to manage waste
- Modifying existing waste management facilities or constructing new facilities at particular sites
- Operating modified or new waste management facilities at those sites
- Transporting wastes among sites as necessary
- Handling, surveillance, and maintenance

The WM PEIS will help DOE select a configuration for the following activities:

- Treatment and disposal of LLMW
- Treatment and disposal of LLW
- Treatment and storage of TRUW
- Storage of treated (vitrified) HLW in canisters
- Treatment of nonwastewater HW

The decision-making process will follow a "tiered" approach. First, DOE will make broad Departmentwide decisions, supported by this programmatic NEPA review, about which sites will manage which wastes. DOE will follow these broad decisions with an analysis of narrower proposals for the implementation of programmatic decisions in related NEPA reviews. Although DOE intends to identify a configuration (i.e., select sites for waste management activities as a result of this *programmatic* EIS), DOE will take a closer look (including site-specific design, location on the site, operating parameters for new facilities, and site-specific impacts) in *sitewide* or *project-level* NEPA reviews.

To assist DOE in making decisions regarding the sites at which it should locate waste management facilities, this PEIS considers four broad categories of alternatives for each waste type: the No Action Alternative, Decentralized Alternatives that would minimize the transportation of waste between sites, Regionalized Alternatives that would locate waste management facilities at several sites throughout the nation, and

Centralized Alternatives that would locate large waste management facilities at only one or two sites. For certain waste types, DOE considers more than one Regionalized or Centralized alternative in order to vary the number of sites analyzed for waste management facilities and the sites at which the facilities could be located. This variation among alternatives bounds potential impacts and allows the decision maker maximum flexibility to compare impacts of potential waste management configurations when considering alternatives.

1.2 The Legacy of Nuclear Weapons Production

Over the past 50 years, DOE and its predecessor agencies have been responsible for atomic energy and nuclear weapons research and production in the United States. In 1946, the AEA established the Atomic Energy Commission to administer and regulate the production and uses of atomic power. Soon after its inception, the Commission expanded its work from building a stockpile of nuclear weapons to peaceful uses of atomic energy and studies of the health and safety hazards of radioactive materials. In 1974, the Atomic Energy Commission was replaced by two new agencies: the NRC, which was charged with regulating the civilian uses of nuclear power, and the Energy Research and Development Administration, whose duties included the production of the nation's nuclear weapons and control of the nuclear weapons complex—a vast network of research, development, and manufacturing facilities, as well as testing sites. In 1977, the duties of the Energy Research and Development Administration were transferred to the newly created DOE.

At its peak, the nuclear weapons complex consisted of 16 major facilities, including large sites in Nevada, Idaho, Washington, and South Carolina. National laboratories in New Mexico and California designed weapons that were produced from components fabricated in plants located in Colorado, Florida, Missouri, Ohio, Tennessee, and Washington. Like most industrial and manufacturing operations, the production of nuclear weapons generated waste, pollution, and contamination. However, many of the problems posed by DOE's nuclear operations are unlike those associated with any other industry. Among these problems are unique radiation hazards; contaminated structures, such as nuclear reactors; and chemical plants that processed nuclear materials. By far, the largest contributor to the contamination problem which exists at these facilities resulted from producing the nuclear materials required for the weapons. This activity generated large quantities of wastes in plants designed and constructed in the 1940s and 1950s.

Nuclear weapons have played an important role in national security, and the nation continues to maintain an arsenal of nuclear weapons and some production capability. With the end of the Cold War and the nuclear arms race, national priorities have shifted, and waste management and environmental restoration have become central to DOE's mission.

Thus, DOE is faced with an environmental legacy of the Cold War and must provide for the proper management of its wastes and for the environmental restoration of contaminated facilities and sites.[2] DOE faces the challenge of treating, storing, and disposing of its waste inventories, both hazardous (treatment only) and radioactive, that have resulted from its past nuclear energy and weapons research and production, as well as waste that may be generated in the future.

The DOE Office of the Assistant Secretary for Environmental Management was established in 1989, with responsibilities for a variety of waste management and environmental restoration activities. These activities include:

- Stabilizing and maintaining a large number of nuclear materials and facilities
- Managing a large amount and variety of wastes
- Providing safe storage for wastes while building and operating a variety of treatment facilities to prepare wastes for disposal
- Cleaning up areas of existing contamination and pollution—the environmental restoration portion of the environmental management program
- Managing a national program of technology development for environmental cleanup, waste management, and related activities
- Reducing waste through waste minimization and pollution prevention practices at each site
- Providing support for international nonproliferation policies

The DOE Environmental Management Program is continually working to accelerate cleanup schedules, increase efficiency, and foster cooperative relationships with its regulators and stakeholders. However, there is concern whether support can be sustained for a program that may last more than 70 years and cost more than $200 billion (DOE, 1996l). DOE has been challenged to accelerate reduction of this "cleanup mortgage" from the Cold War to reduce long-term economic and environmental liabilities. DOE is working on a 2006 Plan (previously the Ten Year Plan) to meet this challenge (see Section 1.8.2). The goal of this

[2] For an overview of DOE's approach to existing environmental, safety, and health issues throughout the nuclear weapons complex, see *Closing the Circle on the Splitting of the Atom—The Environmental Legacy of Nuclear Weapons Production in the United States and What the Department of Energy is Doing About It* (DOE, 1995a). In addition, DOE's *Baseline Environmental Management Report*, issued in June 1996, examines the costs associated with waste management and environmental restoration activities (DOE, 1996l).

plan is that, within the next decade, most DOE facilities will be able to treat and dispose of the backlog of wastes safely and to clean up their land and buildings. These steps would dramatically reduce long-term costs and open a large portion of the land and other resources controlled by DOE for other purposes.

1.3 How the WM PEIS Is Organized

Volume I of the WM PEIS contains the main text of the document. The remainder of this chapter describes the statutory and regulatory constraints under which DOE must operate in managing its waste, defines the five waste types that are analyzed in the WM PEIS, and discusses the waste management sites that are the focus of the document. The chapter also outlines the decisions that DOE expects to make on the basis of the WM PEIS and the relationship of the WM PEIS to other ongoing and planned DOE actions and programs.

Following this introductory chapter, the purpose and need for DOE action (Chapter 2), the alternatives (Chapter 3), the affected environment (Chapter 4), and the impact analysis methodologies (Chapter 5) are described and discussed. Chapters 6 through 10 analyze the health risk, environmental and socioeconomic impacts, and costs associated with each of the alternatives for each waste type. Chapter 11 examines the cumulative effects of the alternatives and other ongoing and proposed DOE activities. Chapter 12 discusses mitigation as well as unavoidable and irreversible impacts of the alternatives. A glossary is also provided in Volume I, Chapter 14.

Volume II consists of tables, organized by major site, that contain information regarding the potential impacts associated with all of the alternatives for the five waste types at those sites.

DOE has also prepared extensive appendices (Volumes III and IV) and technical reports that provide supporting data as well as in-depth descriptions and explanations of a variety of issues. A list of these background documents is provided in Chapter 15 at the end of this volume. Responses to public comments on the Draft WM PEIS are in Volume V.

1.4 Consultations, Laws, and Requirements

This section identifies and summarizes the major laws, regulations, executive orders, and DOE orders that may apply to the programmatic alternatives for WM.

Section 1.4.1 discusses the major Federal statutes that impose environmental requirements upon DOE. In addition, there may be other Federal, State, and local measures applicable to the Waste Management Program because Federal law delegates enforcement authority to State or local agencies. Section 1.4.2 addresses environmentally related presidential executive orders that clarify issues of national policy and set guidelines under which Federal agencies, including DOE, must act. DOE implements its responsibilities for protection of public health, safety, and the environment through a series of departmental orders that impose requirements on the operating contractors of DOE facilities. Section 1.4.3 discusses those DOE orders related to the environment, health, and safety. Hazardous and radioactive materials transportation regulations are summarized in Section 1.4.4. Section 1.4.5 describes DOE's relationship to agencies and organizations, including American Indian Tribes.

1.4.1 Federal Environmental Statutes and Regulations

Some laws require DOE to obtain permits from the EPA or States before constructing and operating waste management facilities that discharge effluent, emit air pollutants, or treat or dispose of toxic substances. Wherever new facilities are located as a result of the decisions made on the basis of the WM PEIS, existing permits will need to be amended or new permits obtained.

National Environmental Policy Act of 1969, as Amended (42 USC §§4321 *et seq.*). NEPA establishes a national policy that promotes awareness of the environmental consequences of the activity of humans on the environment and consideration of the environmental impacts during the planning and decision-making stages of a project. NEPA requires all agencies of the Federal government to prepare a detailed statement on the environmental effects of proposed major Federal actions that may significantly affect the quality of the human environment.

Key Statutes

National Environmental Policy Act (NEPA). *In addition to establishing a broad national policy on the environment, NEPA requires DOE and all other Federal agencies to consider the potential environmental consequences related to proposed actions and requires them to prepare detailed statements on the environmental effects of major actions, alternatives to the action, and measures to avoid or minimize adverse effects.*

Resource Conservation and Recovery Act (RCRA). *The statute outlines the framework for national programs to achieve environmentally sound management of HW from "cradle to grave" and requires agencies, including DOE, to follow specific regulations, procedures, and standards for managing HW, including the hazardous components of radioactive waste (mixed waste).*

Federal Facility Compliance Act (FFCAct). *An amendment to RCRA, the FFCAct waives immunity for DOE and other Federal agencies, allowing States and the EPA to impose fines and penalties for RCRA violations. DOE may avoid these penalties and fines if they are otherwise in compliance with approved site treatment plans.*

Atomic Energy Act (AEA). *The AEA provides the authority for DOE to develop procedures and standards to ensure proper and safe management of radioactive materials.*

Nuclear Waste Policy Act (NWPA). *This Act authorizes Federal agencies to develop a geologic repository for the permanent disposal of spent nuclear fuel and high-level radioactive waste. The Act specifies the process for selecting a repository site and constructing, operating, closing, and decommissioning the repository. The Act also establishes programmatic guidance for these activities.*

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). *Also known as "Superfund," CERCLA outlines the framework for liability, compensation, remediation, and emergency response for hazardous substances released into the environment and for the remediation of inactive hazardous waste disposal sites. CERCLA also provides the basis for requirements affecting DOE's environmental restoration activities.*

This PEIS has been prepared in accordance with the Council on Environmental Quality's (CEQ's) NEPA Implementing Regulations (40 CFR Parts 1500–1508) and DOE's Implementing Procedures (10 CFR Part 1021).

Both the CEQ and DOE regulations encourage the preparation of a programmatic EIS for broad Federal actions (40 CFR 1502.4 and 10 CFR 1021.330). An agency preparing an EIS may then "tier" from the broad, programmatic EIS to one of narrower scope in order to eliminate repetitive discussions and to focus on the issues ready for decision (40 CFR 1502.20; 10 CFR 1021.210). "Tiering" means that when a PEIS has been prepared, a subsequent NEPA document need only summarize or incorporate by reference the issues discussed in the broader statement.

This PEIS has been prepared to assist DOE in determining the sites at which it should either continue to operate certain waste management facilities or locate new facilities. Project-level environmental impact statements (EISs) or environmental assessments (EAs) will assess the environmental impacts of applying alternative treatment, storage, and disposal technologies, and the impacts of constructing and operating these facilities at specific locations on the selected sites.

The CEQ and DOE regulations require the preparation of EISs in two stages, draft and final (40 CFR 1502.9; 10 CFR 1021.313). The draft and final EISs must contain discussions of the purpose and need for the proposed action; reasonable alternatives to the proposed action, including the "No Action" Alternative; the environment potentially affected by the proposed action and the alternatives; and the environmental consequences of the proposed action and alternatives (40 CFR 1502.10 and 10 CFR 1021.310), including cumulative effects and recommended mitigation and monitoring. At the time the agency reaches a decision, but no sooner than 30 days after completing the Final EIS, the agency preparing the EIS must prepare one or more Records of Decision that state what the decisions are and identify the alternatives considered (40 CFR 1505.2; 10 CFR 1021.315).

Resource Conservation and Recovery Act (RCRA). DOE's management of wastes with hazardous constituents (LLMW, some TRUW, HLW, and HW) must comply with the RCRA (42 USC 6901 *et seq.*). RCRA was enacted to ensure the safe and environmentally responsible management of hazardous and nonhazardous solid waste, and to promote resource recovery techniques to minimize waste volumes. Regulations issued by EPA under RCRA set forth a comprehensive program to provide "cradle to grave" control of HW by requiring generators and transporters of HW, and owners and operators of treatment, storage, and disposal facilities, to meet specific standards and procedures. Hazardous waste is defined under RCRA as a waste that poses a potential hazard to human health or the environment when improperly treated, stored, or disposed.

The RCRA regulations include requirements for locating and operating treatment, storage, and disposal facilities. RCRA also required EPA to issue regulations containing land disposal restrictions (LDRs) that require the use of the best demonstrated available technologies to treat certain HW and waste containing certain hazardous constituents. The land disposal restrictions also prohibit storing waste that requires treatment except to facilitate proper recovery, treatment, or disposal. Much of DOE's waste that is currently stored, as well as some waste that it will generate in the future, is HW or contains hazardous constituents that are subject to RCRA and LDRs. DOE facilities that store, treat, or dispose of HW or waste containing hazardous constituents subject to RCRA requirements must obtain a permit from EPA, or from States that are delegated permitting authority by EPA, before such facilities can be constructed and operated. States granted permitting authority by EPA can adopt more stringent requirements.

Federal Facility Compliance Act (FFCAct). The 1992 FFCAct (42 USC §6961) waives DOE's sovereign immunity by allowing States to impose fines and penalties for RCRA violations. The FFCAct also requires DOE to prepare plans for developing treatment capacity for its mixed wastes (waste containing both radioactive and hazardous components subject to RCRA requirements). The FFCAct subjects DOE to fines and penalties after October 6, 1995, for DOE's violations at sites of RCRA's LDRs for waste storage unless the site is otherwise in compliance with an approved STP and compliance order issued by the appropriate regulator. DOE expects and intends that the environmental impact analysis contained in the WM PEIS will also be used by regulators and other stakeholders involved in the FFCAct implementation process. Sixteen of the 17 major sites analyzed in the WM PEIS are required to prepare site treatment plans (STPs). Each of these sites has submitted an STP, and all but three (ANL-E, BNL, and LLNL) have been approved by the appropriate agency. Compliance orders or agreements have incorporated the approved STPs.

Atomic Energy Act (AEA). DOE must also comply with the AEA (42 USC §§2011 *et seq.*) in managing its radioactive wastes. One purpose of the Act is to ensure proper management—production, possession, and use—of radioactive materials. The AEA and other related legislation (including the Energy Reorganization Act of 1974 and the Department of Energy Organization Act of 1977) authorize DOE to develop generally applicable standards for protecting the environment from radioactive materials. Pursuant to the AEA, DOE has established a system of standards and requirements, issued as DOE Orders.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as Amended (42 USC §§9601 *et seq.*). The Comprehensive Environmental Response, Compensation, and Liability Act provides a statutory framework for the cleanup of waste sites containing hazardous substances and — as amended by the Superfund Amendments and Reauthorization Act (SARA) — provides an emergency response program in the event of a release (or threat of a release) of a hazardous substance to the environment. Using the Hazard Ranking System, Federal and private sites are ranked and may be included on the National Priorities List. The Act requires such Federal facilities having such sites to undertake investigations and remediation as necessary. The Act also includes requirements for reporting releases of certain hazardous substances in excess of specified amounts to State and Federal agencies.

Nuclear Waste Policy Act of 1982, as Amended (42 USC §§10101–10270). The Nuclear Waste Policy Act established a national policy for disposal of HLW and spent nuclear fuel (SNF) in a geologic repository and directed DOE to characterize the Yucca Mountain site in Nevada for suitability as the site of a first United States repository. The Act authorizes disposal of HLW and SNL in the first repository, subject to a limit on repository capacity and the payment of appropriate fees. The Act specifically instructs the NRC to limit the first geologic repository to 70,000 metric tons of heavy metal or a quantity of solidified HLW resulting from the reprocessing of such a quantity of SNF until such time as a second geologic repository is in operation. For planning purposes, DOE assumes that some or all of the Hanford Site HLW that satisfies the repository's acceptance criteria could be placed in the potential geologic repositories developed under the Nuclear Waste Policy Act.

Sufficient information is not available to determine at this time whether the Yucca Mountain site is a suitable candidate for geologic disposal of SNF and HLW. DOE, however, is in the early planning stages for a repository EIS. DOE has issued a formal notice of its intent to prepare this analysis. The repository EIS will evaluate potential environmental impacts using the best available information and data and would support the Secretary of Energy's final recommendation to the President, as required by the Nuclear Waste Policy Act. The repository EIS would examine the site-specific environmental impacts from construction, operation, and eventual closure of the repository, including potential post-closure radiological effects to the environment, and would assess the impacts of transporting SNF and HLW to a repository.

The Nuclear Waste Policy Act provides that any repository for the disposal of HLW resulting only from atomic energy defense activities shall be subject to licensing under Section 202 of the Energy Reorganization Act of 1974 (42 USC §5842). Further, Section 202 of the Energy Reorganization Act authorizes NRC licensing of facilities authorized for the express purpose of long-term storage of HLW that are not used for, or are not a part of, research and development activities. Therefore, to the extent that any decision requires defense HLW to be placed in a repository constructed under the Nuclear Waste Policy Act or a facility subject to licensing under Section 202 of the Energy Reorganization Act, such a repository or facility would be subject to licensing by the NRC. NRC's regulations governing the licensing of a geologic repository are contained in 10 CFR Part 60.

The Nuclear Waste Policy Act also directed EPA to promulgate waste standards pursuant to the Atomic Energy Act. EPA responded by issuing the "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Wastes" (final rule) in 40 CFR Part 191. The final rule announcement (58 FR 66398) notes that 40 CFR 191 does not apply to the candidate Yucca Mountain site.

The final version of 40 CFR 191 consists of three subparts. Subpart A establishes dose limits for members of the public, including doses resulting from management and storage of SNF and HLW or TRUW at any disposal facility operated by DOE that is not regulated by NRC or by agreement States. Subpart B establishes containment requirements, assurance requirements, and individual protection requirements for disposal systems for SNF, HLW, and TRUW. This part specifies a 10,000-year design objective and discusses requirements for institutional controls; monitoring performance of a disposal system; designation by records, markers, and passive controls; and retrievability of wastes. Subpart C establishes groundwater protection standards for underground sources of drinking water for disposal systems for SNF, HLW, and TRUW.

The rule was developed primarily for mined geologic repositories. However, EPA states that "Although developed primarily through consideration of mined geologic repositories, 40 CFR 191... applies to disposal of the subject wastes by any method with three exceptions." The standards do not apply to ocean disposal or disposal that occurred before the 1985 standards. The groundwater protection requirements of Subpart C may not apply to disposal systems located within a quarter mile of an underground source of drinking water.

Occupational Safety and Health Act of 1970, as Amended (29 USC §§651 *et seq.*). The Occupational Safety and Health Act establishes standards to enhance safe and healthful working conditions in places of employment throughout the United States. The Act is administered and enforced by the Occupational Safety and Health Administration (OSHA), a U.S. Department of Labor agency. While OSHA and EPA both have a mandate to reduce exposures to toxic substances, OSHA's jurisdiction is limited to safety and health conditions that exist in the workplace environment. In general, under the Act, it is the duty of each employer to furnish all employees a place of employment free of recognized hazards likely to cause death or serious physical harm. Employees have a duty to comply with the occupational safety and health standards and all rules, regulations, and orders issued under the Act. OSHA regulations (published in Title 29 of the *Code of Federal Regulations*) establish specific standards telling employers what must be done to achieve a safe and healthful working environment. DOE emphasizes compliance with these regulations at its facilities and prescribes through DOE orders the standards that contractors shall meet, during their work at Government-owned, contractor-operated facilities (DOE Orders 5480.1B, 5483.1A).

DOE keeps and makes available the various records of illnesses, injuries, and work-related deaths as required by OSHA regulations.

Clean Air Act, as Amended (42 USC §§7401 *et seq.*). The Clean Air Act is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." Section 118 of the Clean Air Act requires that each Federal agency, such as DOE, with jurisdiction over any property or facility that might result in the discharge of air pollutants, comply with "all Federal, state, interstate, and local requirements" with regard to the control and abatement of air pollution.

The Act requires EPA to establish National Ambient Air Quality Standards as necessary to protect public health, with an adequate margin of safety, from any known or anticipated adverse effects of a regulated pollutant (42 USC §7409). The Act also requires establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 USC §7411) and requires specific emission increases to be evaluated so as to prevent a significant deterioration in air quality (42 USC §7470). Hazardous air pollutants, including radionuclides, are regulated separately (42 USC §7412). Air emissions are regulated by EPA in 40 CFR Parts 50 through 99. In particular, radionuclide emissions and hazardous air pollutants are regulated under the National Emission Standard for Hazardous Air Pollutants Program (see 40 CFR Part 61 and 40 CFR Part 63).

Safe Drinking Water Act, as Amended (42 USC §§300[F] *et seq.*). The primary objective of the Safe Drinking Water Act is to protect the quality of the public water supplies and all sources of drinking water. The implementing regulations, administered by EPA unless delegated to the States, establish standards applicable to public water systems. They promulgate maximum contaminant levels, including those for radioactivity, in public water systems. Safe Drinking Water Act requirements have been promulgated by EPA in 40 CFR Parts 100 through 149. Other programs established by the Safe Drinking Water Act include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program.

Clean Water Act, as Amended (33 USC §§1251 *et seq.*). The Clean Water Act, which amended the Federal Water Pollution Control Act, was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." The Clean Water Act prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. Section 313 of the Clean Water Act requires all branches of the Federal government engaged in any activity that might result in a discharge or runoff of pollutants to surface waters to comply with Federal, State, interstate, and local requirements. In addition to setting water quality standards for the Nation's waterways, the Clean Water Act supplies guidelines and limitations for effluent discharges from point-source discharges and provides authority for EPA to implement the National Pollutant Discharge Elimination System permitting program. The National Pollutant Discharge Elimination System program is administered by the Water Management Division of EPA pursuant to regulations in 40 CFR Part 122 *et seq.*

Sections 401 and 405 of the Water Quality Act of 1987 added Section 402(p) to the Clean Water Act. Section 402(p) requires that the Environmental Protection Act establish regulations for issuing permits for stormwater discharges associated with industrial activity. Stormwater discharges associated with industrial activity are permitted through the National Pollutant Discharge Elimination System. General Permit requirements are published in 40 CFR Part 122.

Emergency Planning and Community Right-to-Know Act of 1986 (42 USC §§11001 *et seq.*) (also known as "SARA Title III"). Under Subtitle A of this Act, Federal facilities, including those owned by DOE, provide various information (such as inventories of specific chemicals used or stored and releases that occur from these sites) to the State Emergency Response Commission and to the Local Emergency Planning Committee to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances. Implementation of the provisions of this Act began voluntarily in 1987, and inventory and annual emissions reporting began in 1988 based on 1987 activities and information. In 1993, Executive Order 12856 (see Section 1.4.2, below) directed compliance by Federal agencies. The requirements for this Act were promulgated by EPA in 40 CFR Parts 350–372.

Toxic Substances Control Act (15 USC §§2601 *et seq.*). The Toxic Substances Control Act provides EPA with the authority to require testing of chemical substances, both new and old, entering the environment, and regulates them where necessary. The law complements existing toxic substance laws such as §112 of the Clean Air Act and §307 of the Clean Water Act. The Act came about because there were no general Federal regulations for the potential environmental or health effects of the thousands of new chemicals developed each year before they were introduced into the public or commerce. The Act also regulates the treatment, storage, and disposal of certain toxic substances, specifically polychlorinated biphenyls, chlorofluorocarbons, asbestos, dioxins, certain metal-working fluids, and hexavalent chromium. The asbestos regulations under the Act were ultimately overturned. However, regulations pertaining to asbestos removal, storage, and disposal are promulgated through the National Emission Standard for Hazardous Air Pollutants Program (40 CFR Part 61, Subpart M). For chlorofluorocarbons, Title VI of the Clean Air Act Amendments of 1990 requires a reduction of chlorofluorocarbons beginning in 1991 and prohibits production beginning in 2000.

Pollution Prevention Act of 1990 (42 USC §§13101 *et seq.*). The Pollution Prevention Act of 1990 establishes a national policy for waste management and pollution control that focuses first on source reduction, followed sequentially by environmentally safe recycling, treatment, and lastly, disposal. Disposal or releases to the environment should only occur as a last resort. In response, DOE has committed to participation in the Superfund Amendments and Reauthorization Act Section 313, U.S. Environmental Protection Agency 33/50 Pollution Prevention Program. The goal, for facilities already involved in Section 313 compliance, is to achieve a 33% reduction in the release of 17 priority chemicals by 1997, from a 1993 baseline. On August 3, 1993, Executive Order 12856 was issued, expanding the 33/50 program such that DOE must reduce its total releases of all toxic chemicals by 50% by December 31, 1999. The DOE is also requiring each DOE site to establish site-specific goals to reduce generation of all waste types.

National Historic Preservation Act, as Amended (16 USC §§470 *et seq.*). The National Historic Preservation Act provides that sites with significant national historic value be placed on the *National Register of Historic Places*. No permits or certifications are required under the Act. However, if a particular Federal activity may impact a historic property resource, consultation with the Advisory Council on Historic Preservation will generally result in a Memorandum of Agreement, including stipulations that must be followed to minimize adverse impacts. Coordination with the State Historic Preservation officer is also undertaken to ensure that potentially significant sites are properly identified and appropriate mitigative actions are implemented.

Archaeological Resource Protection Act, as Amended (16 USC §§470aa *et seq.*). This Act protects archaeological resources and sites on public and Indian lands. It requires a permit for any excavation or removal of archaeological resources from public or Indian lands. Excavations must be undertaken for the purpose of furthering archaeological knowledge in the public interest, and resources removed are to remain the property of the United States. Indian tribes must be notified of possible harm or destruction of sites having religious or cultural importance. For resources on Indian tribes, consent must be obtained from the Indian tribe owning the lands on which a resource is located before issuance of a permit, and the permit must contain terms or conditions requested by the tribe.

Native American Grave Protection and Repatriation Act of 1990 (25 USC §§3001 *et seq*.). This Act requires Federal agencies and federally funded museums to repatriate human remains, sacred objects, and objects of cultural patrimony to the culturally affiliated Native American groups. This includes repatriation of cultural items in collections, proof of consultation with appropriate Native American groups for excavation on Federal or tribal lands, and notification of the Federal land manager and appropriate Native American group when an inadvertent discovery is made on Federal or tribal land. Any cultural items excavated after November 16, 1990, pertaining to this Act are owned by lineal descendants.

American Indian Religious Freedom Act of 1978 (42 USC §1996). This Act reaffirms Native American religious freedom under the First Amendment and sets United States policy to protect and preserve the inherent and constitutional right of American Indians to believe, express, and exercise their traditional religions. This Act requires that Federal actions avoid interfering with access to sacred locations and traditional resources that are integral to the practice of religions.

Religious Freedom Restoration Act of 1993 (42 USC §§2000bb *et seq*.). This Act prohibits the Government, including Federal departments, from substantially burdening the exercise of religion unless the Government demonstrates a compelling governmental interest and the action furthers that interest and is the least restrictive means of furthering that interest.

Endangered Species Act, as Amended (16 USC §§1531 *et seq*.). The Endangered Species Act is intended to prevent the further decline of endangered and threatened species and to restore these species and their habitats. The Act is jointly administered by the U.S. Departments of Commerce and the Interior. Section 7 of the Act requires consultation with the U.S. Fish and Wildlife Service to determine whether endangered and threatened species or their critical habitats are known to be in the vicinity of the proposed action.

Migratory Bird Treaty Act, as Amended (16 USC §§703 *et seq*.). The Migratory Bird Treaty Act is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. It regulates the harvest of migratory birds by specifying mode of harvest, hunting seasons, and bag limits. The Act stipulates that it is unlawful at any time, by any means, or in any manner to "kill . . . any migratory bird." Although no permit for this project is required under the Act, DOE is required to consult with the U.S. Fish and Wildlife Service regarding impacts to migratory birds and to evaluate ways to avoid or minimize these effects in accordance with the U.S. Fish and Wildlife Service Mitigation Policy.

Bald and Golden Eagle Protection Act, as Amended (16 USC §§668–668d). The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, molest, or disturb bald (American) and golden eagles, their nests, or their eggs anywhere in the United States (Section 668, 688c). A permit must be obtained from the U.S. Department of the Interior to relocate a nest that interferes with resource development or recovery operations.

Wild and Scenic Rivers Act, as Amended (16 USC §§1271 *et seq.* 71:8301 *et seq.*). The Wild and Scenic Rivers Act protects certain selected rivers of the Nation, which possess outstanding scenic, recreational, geological, fish and wildlife, historical, cultural, or other similar values. These rivers are to be preserved in a free-flowing condition to protect water quality and other vital national conservation purposes. The purpose of the Act is to institute a national wild and scenic rivers system, to designate the initial rivers that are a part of that system, and to develop standards for the addition of new rivers in the future.

Noise Control Act of 1972, as Amended (42 USC §§4901 *et seq.*). Section 4 of the Noise Control Act of 1972, as amended, directs all Federal agencies to carry out "to the fullest extent within their authority" programs within their jurisdictions in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health and welfare.

In addition to these laws, the Nuclear Waste Policy Act (42 USC §§10101–10270) authorizes the development of a geologic repository for the permanent disposal of spent nuclear fuel and HLW. The West Valley Demonstration Project Act was enacted in 1980 and authorizes DOE (1) to develop a solidification process that can be used to prepare HLW for disposal and (2) to conduct a nuclear waste management project on the site of the Western New York Nuclear Service Center near West Valley, New York.

1.4.2 Executive Orders

Executive Order 12088, Federal Compliance With Pollution Control Standards (10/13/78). As amended by Executive Order 12580 (January 23, 1987), Federal Compliance with Pollution Control Standards, Executive Order 12088 directs Federal agencies, including DOE, to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the Clean Air Act, the Noise Control Act, the Clean Water Act, the Safe Drinking Water Act, the Toxic Substances Control Act (15 USC §§2601 *et seq.*), and the Resource Conservation and Recovery Act.

Executive Order 11593, National Historic Preservation (5/13/71). Executive Order 11593 directs Federal agencies, including DOE, to locate, inventory, and nominate properties under their jurisdiction or control to the *National Register of Historic Places* if those properties qualify. This process requires DOE to provide the Advisory Council on Historic Preservation the opportunity to comment on the possible impacts of the proposed activity on any potential eligible or listed resources.

Executive Order 11514, Protection and Enhancement of Environmental Quality. Executive Order 11514 directs Federal agencies to continually monitor and control their activities to protect and enhance the quality of the environment and to develop procedures to ensure that fullest practicable provision of timely public information and understanding of the Federal plans and programs with environmental impact to obtain the views of interested parties. The DOE has issued regulations (10 CFR Part 1021) and DOE Order 451.1 for compliance with this executive order.

Executive Order 11988, Floodplain Management. Executive Order 11988 directs Federal agencies to establish procedures to ensure that the potential effects of flood hazards and floodplain management are considered for any action undertaken in a floodplain and that floodplain impacts be avoided to the extent practicable.

Executive Order 11990, Protection of Wetlands. Executive Order 11990 directs governmental agencies to avoid, to the extent practicable, any short- and long-term adverse impacts on wetlands wherever there is a practicable alternative.

Executive Order 12580, Superfund Implementation. Executive Order 12580 delegates to the heads of executive departments and agencies the responsibility for undertaking remedial actions for releases or threatened releases that are not on the National Priority List and removal actions at any facility under the jurisdiction or control of executive departments and agencies.

Executive Order 12856, Right to Know Laws and Pollution Prevention Requirements. This order directs all Federal agencies to reduce and report toxic chemicals entering any waste stream; improve emergency planning, response, and accident notification; and encourage clean technologies and testing of innovative prevention technologies. The Executive Order also provides that Federal agencies are persons for purposes of the Emergency Planning and Community Right-to-Know Act (SARA Title III), which obliges agencies to meet the requirements of the Act.

Executive Order 12898, Environmental Justice. This order directs Federal agencies to promote environmental justice by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions. The order creates an Interagency Working Group on Environmental Justice and directs each Federal agency to develop strategies within prescribed time limits to identify and address environmental justice concerns. The order further directs each Federal agency to collect, maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have a substantial environmental, human health, or economic effect on the surrounding populations, when such facilities or sites become the subject of a substantial Federal environmental administrative or judicial action and to make such information publicly available.

Executive Order 12114, Environmental Effects Abroad of Major Federal Actions. This order declares that Federal agencies are required to prepare environmental analyses for "major Federal actions significantly affecting the environment of the global commons outside the jurisdiction of any nation (e.g., the ocean or Antarctica)." According to the Executive Order, major Federal actions significantly affecting the environment of foreign countries may also require environmental analyses under certain circumstances. The procedural requirements imposed by the Executive Order are analogous to those under the National Environmental Policy Act.

Executive Order 13007, Sacred Sites. Executive Order 13007 directs Executive agencies, to the extent permitted by law and not inconsistent with agency missions, to avoid adversely affecting sacred sites and to provide access to Native American religious practitioners for religious practices.

1.4.3 Department of Energy Regulations and Orders

Through the authority of the Atomic Energy Act, DOE is responsible for establishing a comprehensive health, safety, and environmental program for its facilities. The regulatory mechanisms through which DOE manages its facilities are the promulgation of regulations and the issuance of DOE orders.

The DOE regulations are generally found in Title 10 of the Code of Federal Regulations. These regulations address such areas as energy conservation, administrative requirements and procedures, nuclear safety, and classified information. For purposes of this PEIS, relevant regulations include 10 CFR Part 820, Procedures for DOE Nuclear Activities; 10 CFR Part 830.120, Quality Assurance; 10 CFR Part 834, Radiation Protection of the Public and the Environment (proposed); 10 CFR Part 835, Occupational Radiation Protection; 10 CFR Part 1021, Compliance with the National Environmental Policy Act; and 10 CFR Part 1022, Compliance with Floodplains/Wetlands Environmental Review Requirements.

DOE orders generally set forth policy and the programs and internal procedures for implementing those policies. The following sections provide a brief discussion of selected orders.

DOE Order 151.1, Comprehensive Emergency Management System (9/25/95). This order describes the roles and responsibilities for the DOE Emergency Management System. One purpose of the order is to ensure that the DOE Emergency Management System is ready to respond promptly, efficiently, and effectively to any emergency involving DOE facilities, activities, or operations. The order requires emergency planning for DOE sites/facilities, including DOE transportation activities, in order to ensure personnel and resources are prepared to respond effectively to emergencies.

DOE Order 451.1, National Environmental Policy Act Compliance Program (9/11/95). This order sets forth DOE internal requirements and responsibilities for implementing the NEPA and associated regulations, including preparation of environmental impact assessments. It also directs Agency personnel to "incorporate NEPA values . . . to the extent practicable, in DOE documents prepared under [CERCLA]."

DOE Order 5820.2A, Radioactive Waste Management (9/26/88). DOE Order 5820.2A establishes policies and guidelines for management of radioactive waste and contaminated facilities. The generation, treatment, storage, transportation, and/or disposal of such wastes is to be accomplished in a manner that complies with all applicable Federal, state, and local environmental, safety, and health laws and regulations, as well as DOE requirements. The order contains materials pertaining to management of high-level waste, transuranic waste, low-level waste, and other types of radioactive waste, plus guidelines on decommissioning of radioactively contaminated facilities. DOE is currently in the process of updating this order.

10 CFR Part 835, Occupational Radiation Protection. This rule establishes radiation protection standards, limits, and program requirements for occupational exposure at DOE facilities and operations. Each activity must have a Radiation Protection Program. The order sets the goal of minimizing workplace exposure and establishes maximum allowable exposures on the basis of national and international recommended standards. The rule also establishes policies on worker training, workplace monitoring and dosimetry, entry control, and other aspects of workplace radiation safety.

DOE Order 5400.5, Radiation Protection of the Public and the Environment (2/8/90). The purposes of DOE's program on radiation protection of the public and the environment are to: (1) establish dose limits for exposure of members of the public to radiation and implementation of the Department's "as low as reasonably achievable" (ALARA) policy; (2) manage radioactive materials in liquid waste discharges, in soil columns, and in selected solid waste containing radioactive materials, including a groundwater protection program for each DOE site; (3) establish requirements for decontamination, survey, and release of buildings, land, equipment, and personal property containing residual radioactive material and for the management, storage, and disposal of wastes generated by these activities; and (4) establish an "Environmental Radiation Protection Program and plan (including an effluent monitoring and environmental surveillance program) to set forth the programs, plans, and other processes to protect the public from exposures to radiation. DOE is in the process of codifying this policy; Proposed Rule 10 CFR 834 was issued for comment on March 25, 1993.

1.4.4 Hazardous and Radioactive Materials Transportation Regulations

Transportation of hazardous and radioactive materials, substances, and wastes is governed by the U.S. Department of Transportation, NRC, EPA regulations, and the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171–178, 49 CFR Parts 383–397, 10 CFR Part 71, and 40 CFR Part 262 and 265, respectively.

U.S. Department of Transportation regulations contain requirements for identifying a material as hazardous or radioactive. These regulations interface with those of the NRC or EPA for identifying material, but the U.S. Department of Transportation hazardous material regulations govern the hazard communication (such as marking, hazard labeling, vehicle placarding, and emergency response telephone number) and shipping requirements (such as required entries on shipping papers or EPA waste manifests).

NRC regulations applicable to radioactive materials transportation are found in 10 CFR Part 71, which includes detailed packaging design requirements and package certification testing requirements. Complete documentation of design and safety analysis and results of the required testing are submitted to the NRC to certify the package for use. This certification testing involves the following components: heat, physical drop onto an unyielding surface, water submersion, puncture by dropping package onto a rigid spike, and gas tightness. Some of the required tests simulate maximum reasonably foreseeable accident conditions.

EPA regulations pertaining to hazardous waste transportation are found in 40 CFR Part 262. These regulations deal with the use of the EPA waste manifest, which is the shipping paper for transporting RCRA hazardous waste.

1.4.5 CONSULTATIONS WITH OTHER AGENCIES, ORGANIZATIONS, AND AMERICAN INDIAN TRIBES

Section 102(2)(c)(v) of NEPA and 40 CFR 1503.1 require that Federal agencies (defined to include American Indian tribes) with jurisdiction or special expertise regarding any environmental impacts be consulted and involved in the National Environmental Policy process. 10 CFR 1502.25 requires consultation with agencies that have the authority to issue applicable permits, licenses, and other regulatory approvals, as well as those responsible for protecting significant resources (for example, endangered species, critical habitats, or cultural resources).

In addition to these provisions, DOE's NEPA regulation 10 CFR 1021.341(b) requires consultation with other agencies when necessary or appropriate. The PEIS Implementation Plan (DOE, 1994b) described the scoping process of the WM PEIS and the extent of EPA involvement in that process. Chapter 5 of the plan summarizes the roles and responsibilities of EPA and DOE with regard to technical coordination on issues of mutual concern. EPA participated by reviewing the Preliminary Draft and Final WM PEIS before they were issued to the public, helping DOE to define issues and concerns to address in the PEIS, and providing information in areas in which EPA has regulatory authority or technical expertise. EPA also participated in meetings involving review of the human health risk methodology. Moreover, during the course of developing the draft and final WM PEIS, DOE invited comment from and held discussions with certain groups with special interests, such as the Environmental Management Advisory Board (EMAB), the Site Specific Advisory Board (SSAB) representatives, and others.

As stated in a Presidential Memorandum (April 29, 1994), "The United States government has a unique legal relationship with Native American tribal governments as set forth in the constitution of the United

States, treaties, statutes, and court decisions." This memorandum directs each executive department to operate within a government-to-government relationship with Federally recognized tribal governments, consult with tribal governments, and assess the impact of Federal government plans, projects, programs, and activities on tribal trust resources. The importance of these relationships and consultations is echoed in the DOE American Indian policy, as implemented by DOE Order 1230.2, which emphasizes the importance of establishing a proactive approach to solicit input from tribal governments on Departmental policies and issues. It also encourages tribal governments and their members to participate fully in national and regional dialogues concerning Departmental programs. Consultation with Federally recognized tribes is also an integral part of compliance with a number of cultural resource statutes and their implementing regulations discussed in Section 1.4.1. DOE has initiated consultation with some of the tribal governments that have trust, treaty, and traditional lands near DOE facilities. In recent years, DOE has worked to build government-to-government relationships with tribes near Departmental sites.

DOE has received comments regarding tribal values and the requirement for government-to-government consultations, which have been considered in this Final WM PEIS. Many issues between DOE and the tribes are dealt with at the site level, such as local cultural resources, and ongoing and planned DOE activities. To facilitate discussion between DOE and the tribes, each local DOE office has a point of contact for tribal issues, including cultural resource and historic preservation issues.

The WM PEIS analysis focuses mainly on alternatives addressing national-level strategic issues. Follow-on project and site-specific NEPA reviews will be conducted that will more fully explore specific concerns related to the respective sites. During these reviews, local DOE offices will work with other agency and tribal representatives as well as members of the interested public to identify the locations of any necessary facilities and related activities such as transportation. It is during this next level of planning and project-level implementation that specific values and environmental impact analyses will be considered.

1.5 Waste Types

DOE is responsible for managing large inventories of LLMW, LLW, TRUW, HLW, and HW. DOE manages each of these waste types separately because they have different components, have different levels of radioactivity, and must meet different regulatory requirements. The definitions of these waste types have different bases: some are defined by source, some by physical or chemical characteristics, and some by exception. Moreover, a given radionuclide can appear in more than one waste type but usually in different concentration.

LLMW and LLW are categorized either as alpha or nonalpha waste, depending on whether the waste contains concentrations of alpha particles at or above 10 nanocuries per gram. All TRUW is alpha waste. There are typically two categories of LLMW, LLW, and TRUW—"contact-handled" (CH) and "remote-handled" (RH). The categories differ because of the concentration of radioactive materials. Remote-handled waste typically requires additional shielding and containment to protect workers and the public.

Types of Radioactivity

The four principal types of radiation are: alpha particles, beta particles, gamma rays, and neutrons. ***Alpha radiation*** *can be stopped by a sheet of paper and will not penetrate skin, but it is harmful if ingested or inhaled.* ***Beta radiation*** *can pass through an inch of water or skin, but not through a thin sheet of aluminum, plywood, or steel.* ***Gamma rays and neutrons*** *are the most penetrating radiation and can pass through many materials, including the human body. Dense materials like lead are effective for stopping gamma rays, whereas hydrogenous materials like water are effective in slowing down and stopping neutrons.*

The following sections define and discuss each of the waste types considered in this PEIS. The environmental impacts associated with managing those wastes types under the four broad categories of alternatives are contained in the waste-type Chapters 6 through 10. Privatized management is also considered in this PEIS. Privatization means that the private sector would own (or control) the means for treatment, storage, or disposal of nuclear waste. Privatization is detailed in Section 1.7.4.

1.5.1 Low-Level Mixed Waste

LLMW contains both hazardous and low-level radioactive components. The hazardous component in LLMW is subject to RCRA, whereas the radioactive components are subject to the AEA (42 USC 2011 *et seq.*). LLMW is characterized as either CH or RH and as alpha or nonalpha. LLMW results from a variety of activities, including the processing of nuclear materials used in nuclear weapons production, and energy research and development activities. The WM PEIS evaluates approximately 82,000 cubic meters of LLMW currently stored and an estimated 137,000 cubic meters

Metric Units

Volumes in this document are given in the metric unit of cubic meters. One cubic meter is equal to approximately 35 cubic feet, or 264 gallons.

expected to be generated over the next 20 years (excluding LLMW that could be generated as a result of environmental restoration activities) for a total of approximately 219,000 cubic meters. Presently, commercial and DOE facilities are insufficient to treat DOE's inventory of LLMW. However, it is possible that some portion of the inventory could be treated at commercial facilities and that the capacity of such facilities could increase rapidly if specific DOE sites were to decide to use commercial facilities. This PEIS addresses the treatment and disposal of LLMW; storage of LLMW is not addressed because RCRA prohibits storage of untreated waste except to facilitate proper recovery, treatment, or disposal. Table 1.5–1 summarizes the range of decisions that DOE could make with respect to LLMW.

> ***Contact- and Remote-Handled Wastes***
>
> *Radioactive waste is classified as "contact-handled" or "remote-handled."* ***Contact-handled*** *wastes are those wastes whose external surface dose rate does not exceed 200 millirem per hour.*
>
> ***Remote-handled*** *wastes are those wastes whose external surface dose rate exceeds 200 millirem per hour.*
>
> *LLMW, LLW, and TRUW are categorized as either contact-handled or remote-handled.*

1.5.2 LOW-LEVEL WASTE

LLW includes all radioactive waste that is not classified as HLW, spent nuclear fuel (fuel discharged from nuclear reactors), TRUW, uranium and thorium mill tailings, or waste from processed ore. LLW does not contain hazardous constituents regulated under RCRA. Most LLW consists of relatively large amounts of waste materials contaminated with small amounts of radionuclides, such as contaminated equipment (e.g., gloveboxes, ventilation ducts, shielding, and laboratory equipment), protective clothing, paper, rags, packing material, and solidified sludges. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranics is less than 100 nanocuries per gram of waste. Low-level waste is subject to the provisions of the Atomic Energy Act and is categorized as CH or RH and as alpha or nonalpha on the basis of the types and levels of radioactivity present. However, most LLW contains short-lived radionuclides and generally can be handled without additional shielding or remote handling equipment. DOE has an inventory of approximately 67,500 cubic meters of LLW in storage, and approximately 1,440,000 cubic meters are expected to be generated during the next 20 years (excluding LLW that may be generated as a result of environmental restoration activities), for a total of 1,500,000 cubic meters. This PEIS addresses the treatment and disposal of LLW. Table 1.5–1 summarizes the decisions that DOE must make with respect to LLW.

Table 1.5-1. Decisions DOE Will Make Based on Evaluations in the WM PEIS

Decisions	Type of Waste and Whether DOE Will Decide on Basis of WM PEIS (Yes or No)				
	Low-Level Mixed Waste	**Low-Level Waste**	**Transuranic Waste**	**High-Level Waste**	**Hazardous Waste**
Where to treat?	**YES** LLMW could be treated at 1 to 37 DOE sites.	**YES** LLW volume reduction and treatment could be conducted at 1 to 11 DOE sites. Minimum treatment could occur at all sites.	**YES** TRUW could be treated at 3 to 16 DOE sites.	**NO** HLW will be treated at 4 DOE sites where it was generated.	**YES** HW could be treated at DOE sites, or DOE could rely on commercial treatment.
Where to store?	**NO** LLMW will be stored at sites where generated until treatment and disposal.	**NO** LLW will be stored at sites where generated until treatment and disposal.	**YES** TRUW could be stored at 3 to 16 sites, pending final disposition.	**YES** HLW canisters containing treated HLW could be placed into storage at 1 to 4 DOE sites.	**NO** HW sent to commercial facilities will be stored for less than 90 days unless there is a permitted storage facility.
Where to dispose of?	**YES** LLMW could be disposed of at 1 to 16 DOE sites.	**YES** LLW could be disposed of at 1 to 16 DOE sites.	**NO** Separate evaluation of Waste Isolation Pilot Plant (WIPP) Disposal Phase is being prepared.	**NO** Separate evaluations to be prepared pursuant to the Nuclear Waste Policy Act as amended.	**NO** Commercial HW disposal facilities will continue to be used.

1.5.3 TRANSURANIC WASTE

TRUW is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years and an atomic number greater than 92, except for (a) high-level radioactive waste, (b) waste that the Secretary has determined, with the concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations, or (c) waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.[3] TRUW is produced during reactor fuel assembly, nuclear weapons production, research and development, and spent nuclear fuel reprocessing.

TRUW, some of which also contains hazardous constituents, has radioactive components such as plutonium, with lesser amounts of neptunium, americium, curium, and californium. TRUW components have half-lives greater than 20 years. These radionuclides generally decay by emitting alpha particles. Like LLMW and LLW, TRUW also contains radionuclides that emit gamma rays, requiring TRUW to be managed as either CH or RH. Approximately 60% is mixed waste, containing both radioactive components and hazardous components regulated under RCRA.

[3] LLW and LLMW may also contain these transuranic isotopes, but with concentrations less than 100 nanocuries per gram of waste.

DOE has approximately 68,000 cubic meters of TRUW retrievably stored since 1970, and about 64,000 cubic meters expected to be generated over the next 20 years (excluding TRUW that could be generated as a result of environmental restoration activities), for a total of about 132,000 cubic meters. The waste volumes do not include TRUW generated before 1970. Pre-1970 TRUW is known as "buried TRUW." This waste is considered environmental restoration waste.

> *Quantities of Waste**
>
> ***Low-Level Mixed Waste.*** *The WM PEIS addresses approximately 82,000 cubic meters of LLMW currently stored and an estimated 137,000 cubic meters expected to be generated over the next 20 years.*
>
> ***Low-Level Waste.*** *Approximately 67,500 cubic meters of LLW are stored, and an estimated 1,440,000 cubic meters are expected to be generated over the next 20 years.*
>
> ***Transuranic Waste.*** *Approximately 68,000 cubic meters are retrievably stored, and an estimated 64,000 cubic meters are expected to be generated over the next 20 years.*
>
> ***High-Level Waste.*** *Approximately 378,000 cubic meters of HLW are stored, and limited additional quantities will be generated. Approximately 21,600 HLW canisters are expected to be produced as a result of treating HLW.*
>
> ***Hazardous Waste.*** *Approximately 69,000 cubic meters of nonwastewater HW are expected to be generated in the next 20 years.*
>
> ** Volumes do not include environmental restoration wastes.*

DOE is currently proposing to dispose of retrievably stored and newly generated TRUW in a geologic repository called the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. The environmental impacts of developing WIPP were assessed in previous environmental impact statements (DOE, 1980; DOE, 1990). DOE is examining whether to dispose of TRUW at WIPP in a second supplemental EIS (SEIS-II; DOE, 1996n). Therefore, this PEIS evaluates alternative configurations for the treatment and storage of TRUW. Table 1.5–1 summarizes the decisions that DOE must make with respect to TRUW.

1.5.4 High-Level Waste

HLW is the highly radioactive waste resulting from reprocessing spent nuclear fuel and irradiated targets from reactors and is liquid before it is treated and solidified. Some of its constituents will remain radioactive for thousands of years. HLW is also a mixed waste because it contains hazardous constituents that are regulated under RCRA. DOE has about 378,000 cubic meters of HLW stored in large tanks at far sites.

DOE is proceeding with plans to treat HLW by processing it into a solid form (e.g., borosilicate glass) that would not be readily dispersible into air or leachable into ground or surface water. This treatment process is called vitrification. The environmental impacts of vitrifying HLW have been analyzed in previous DOE environmental impact statements (DOE, 1982a,b; 1987; 1994a; 1995e). Vitrification will result in the generation of approximately 21,600 canisters from the current inventory of HLW. Canisters are assumed to vary in volume between 0.85 cubic meters and 1.26 cubic meters. DOE plans to dispose of the HLW canisters in a geologic repository. This PEIS addresses only the storage of vitrified HLW prior to its ultimate disposal in a geologic repository. Table 1.5-1 summarizes the decisions that DOE must make with respect to HLW.

Spent Nuclear Fuel

"Spent nuclear fuel" is fuel that has been withdrawn from nuclear reactors following irradiation, the constituent elements of which have not been separated. A "target" is material that is placed in a nuclear reactor to be bombarded with neutrons to produce new, manmade radioactive materials, such as plutonium and tritium. Uranium/neptunium target material is managed as spent nuclear fuel.

Initially, DOE intended to evaluate the management of spent nuclear fuel in this PEIS. However, DOE analyzed its management in a separate PEIS—"Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement" published in April 1995. The impacts of managing spent nuclear fuel presented in that PEIS are included in the cumulative impacts of the WM PEIS.

1.5.5 Hazardous Waste

HW is defined as a solid waste that because of its quantity, concentration, or physical, chemical, or infectious characteristics may significantly contribute to an increase in mortality, or may pose a potential hazard to human health or the environment when improperly treated, stored, or disposed. RCRA defines a "solid" waste to include solid, liquid, semisolid, or contained gaseous material (42 USC 6901 *et seq.*). By definition, HW contains no radioactive components. For purposes of this PEIS, HW includes State-designated HW and TSCA wastes in addition to RCRA wastes.

The quantities and types of HW generated as a result of DOE activities vary considerably and include acids, metals, industrial solvents, paints, oils, rags contaminated with hazardous cleaning compounds, and other hazardous materials that are byproducts of routine maintenance and operations. Almost 99% of DOE's HW is wastewater and is treated at DOE sites. Treatment residues and the remaining 1%, predominantly solvents and cleaning agents, are treated at commercial facilities. The WM PEIS evaluates the treatment of nonwastewater HW. Over the next 20 years, approximately 69,000 cubic meters of nonwastewater HW are expected to be generated. Treated HW will continue to be disposed of at commercial facilities. Table 1.5-1 summarizes the decisions that DOE must make with respect to HW.

1.5.6 Waste Types Not Considered

Nonhazardous and nonradioactive sanitary waste, nonhazardous solid waste, hazardous and low-level process wastewater, and commercial "Greater-Than-Class-C" (GTCC) LLW are not considered in the WM PEIS. Additionally, some wastes within the radioactive waste type categories, such as LLW, TRUW, and HLW, have characteristics that require special considerations and different management than most of the other waste within that category. These wastes are "special case wastes" and are managed on a case-by-case basis; they not specifically evaluated in the WM PEIS, although the waste volumes reported in the PEIS largely account for them.

Nonhazardous and nonradioactive sanitary and industrial waste requires limited handling and can be treated or disposed in properly designed facilities or used in energy production. DOE currently manages sanitary and industrial waste on a site-by-site basis. Some DOE sites dispose of this waste in onsite landfills that have permits issued by appropriate State agencies, while other sites use commercial landfills. The types and quantities of sanitary and industrial waste vary considerably from site to site. Sanitary and industrial waste was not included in the scope of wastes to be addressed in the WM PEIS because of the site-specific nature of these wastes and because DOE is not proposing a program for managing it. Sanitary and industrial wastes may be appropriate for consideration in sitewide and project-level NEPA reviews.

Wastewater is treated at the site where it is generated because it is not practical to ship relatively large volumes of wastewater between sites for treatment. Because impacts from hazardous wastewater are independent of programmatic decisions to be made in the WM PEIS and are generally minor, they are not analyzed. For the same reasons, the impacts of managing wastewater contaminated with LLW are not analyzed. Secondary sludges resulting from LLW wastewater treatment are, however, captured in the WM PEIS analysis.

Some wastes at some sites are managed on a case-by-case basis independent of the program applicable to that class of waste. Although not a formal waste category, these wastes are frequently designated "special case wastes" by the generating site.[4] Primarily, these are waste streams within existing waste types that have limited or no disposal alternatives at this time, such as LLW that, because of its high radioactivity levels, does not meet site-specific acceptance criteria, or TRUW that may not meet disposal criteria at WIPP. Classified waste, which requires protection against unauthorized information or material disclosure for reasons of national security, is special case waste when there is no management plan for it. Although it may be categorized as LLW or TRUW, such waste would be managed separately. DOE did not undertake a detailed waste-stream and site-specific analysis in the WM PEIS to develop programmatic alternatives for each of these exceptions. As detailed analyses are conducted, management plans for each waste stream will be established. For example, a more detailed analysis could determine that some LLW currently managed as a special case meets the acceptance criteria for disposal; or, some TRUW could be determined acceptable for disposal at WIPP. These waste streams would no longer be considered special case, and the fact that the waste was once classified as special case waste would no longer be relevant. Such determinations would not be expected to affect the overall conclusions reached in the WM PEIS for a waste type, which are based upon evaluation of the majority of that waste. Additionally, a determination would be made regarding the need for supplemental NEPA reviews on an individual special case waste stream basis.

The PEIS, in general, does not address the management of wastes produced from commercial applications of radiation and atomic energy. For example, the Low-Level Radioactive Waste Policy Amendments Act of 1985 (42 USC 2021 *et seq.*) makes the States responsible for the disposal of commercially generated low-level radioactive waste, and consequently disposal of such LLW is not addressed. However, under this Act (42 USC 2021), DOE is responsible for commercially generated GTCC LLW. Commercial GTCC LLW includes activated metals, process wastes, other contaminated solids generated from the operation of commercial nuclear power plants, and radioactive materials that are used in minerals exploration and as part of medical treatments.

Some waste managed as a special case and GTCC LLW must be isolated from human exposure for periods in excess of hundreds or thousands of years. These wastes are not currently authorized for disposal in a geologic repository under the Nuclear Waste Policy Act (42 USC 10101–10270). On March 13, 1995, DOE published a notice in the *Federal Register* inviting interested parties to provide input into the development

[4] Such wastes account for less than 4% of LLW, LLMW, and TRUW inventories.

of proposed strategies for such wastes. Two workshops were held in April 1995 to discuss preliminary strategies. The Department is currently developing strategies for these wastes.

Not all radioactive materials that are contained in waste are discrete waste types. Special nuclear material, for example, is defined by the Atomic Energy Act to be plutonium, uranium enriched in isotope uranium-235 or -233, and any other material that the U.S. Nuclear Regulatory Commission determines to be special nuclear material pursuant to Section 51 of the Atomic Energy Act of 1954. Special nuclear material is not inherently a waste, and although small quantities of SNM may be present in LLW, LLMW, TRUW, and HLW, SNM of sufficient purity can be used for production of energy or for national defense.

1.6 Waste Management Sites

There are 54 sites for which DOE has some waste management responsibility and that are within the scope of this PEIS. Figure 1.6-1 is a map showing the location of these 54 sites. Table 1.6-1 lists the 54 sites and indicates the type of waste that has been generated, is expected to be generated, or is stored at each site.

54 Waste Management Sites

40	*DOE sites*
11	*Joint DOE/Navy Nuclear Propulsion Program sites*
2	*Formerly Utilized Sites Remedial Action Program sites*
1	*Waste Isolation Pilot Plant*

Of the 54 sites, 40 are DOE sites. DOE is also responsible for 11 sites participating in the joint DOE/Navy Nuclear Propulsion Program, two sites managed under the Formerly Utilized Sites Remedial Action Program, and the WIPP in New Mexico, which may be used in the future for TRUW disposal. Two sites, the Charleston Naval Shipyard and Mare Island Naval Shipyard, which may generate small quantities of LLW in addition to LLMW, have been closed and their properties released for unrestricted use subsequent to their inclusion in the WM PEIS as waste management sites.

To evaluate where to manage each of the five waste types, several of the sites and their wastes have been grouped together, as indicated in Table 1.6-1. These groupings are generally based on geographic proximity (for example, Argonne National Laboratory-West [ANL-W] is located within the site boundary

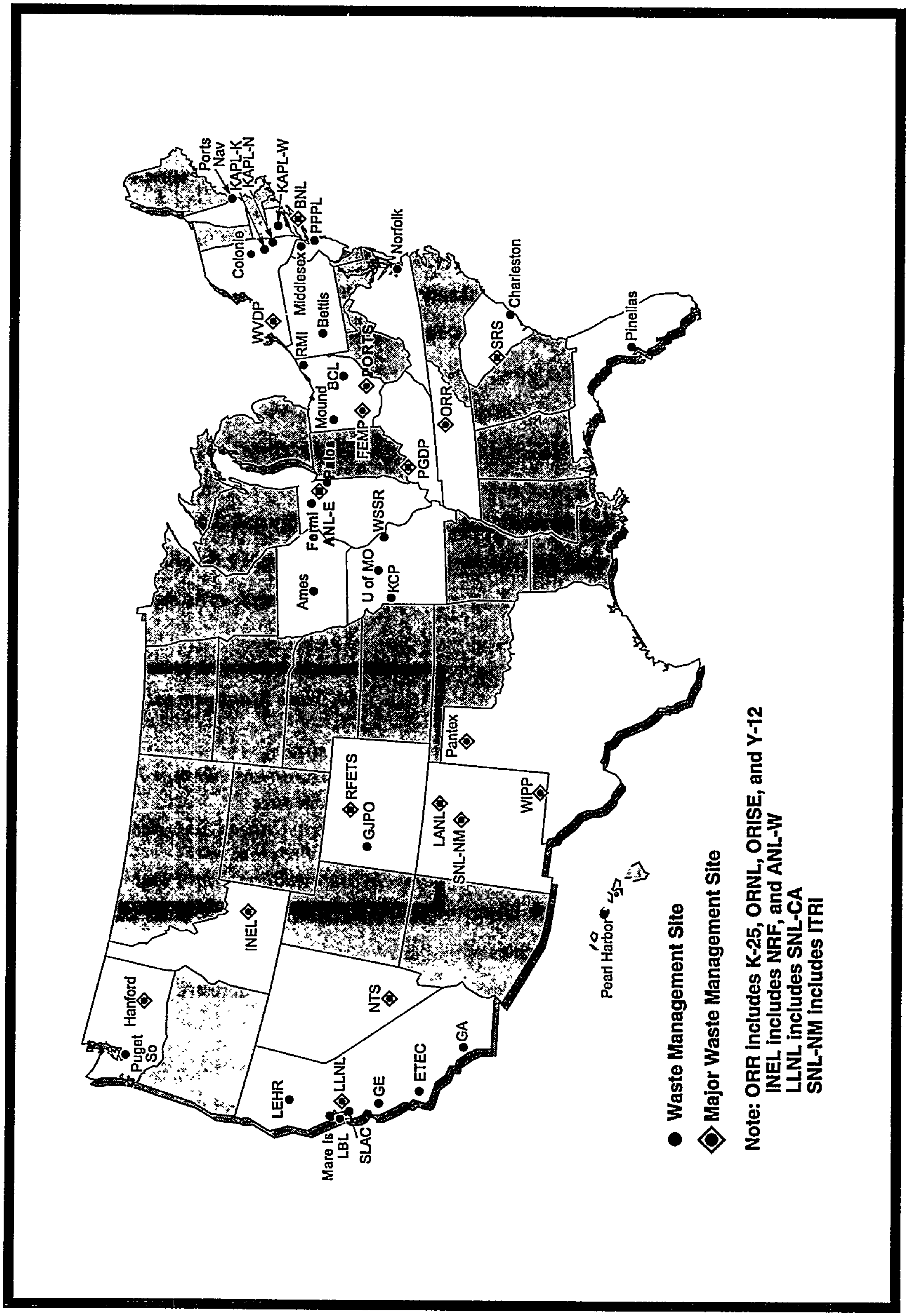

Figure 1.6–1. Waste Management Sites.

Table 1.6–1. Waste Management Sites

Sites	State	Symbol	Major Site[a]	Waste Type Managed				
				LLMW	LLW	TRUW	HLW	HW[b]
1 Ames Laboratory	IA	Ames		✓	✓			
2 Argonne National Laboratory-East	IL	ANL-E	✓	✓	✓	✓		✓
3 Battelle Columbus Laboratories	OH	BCL		✓				
4 Bettis Atomic Power Laboratory	PA	Bettis		✓	✓			
5 Brookhaven National Laboratory	NY	BNL	✓ c	✓	✓			
6 Charleston Naval Shipyard	SC	Charleston		✓	g			
7 Colonie	NY	Colonie		d				
8 Energy Technology Engineering Center	CA	ETEC		✓		✓		
9 Fermi National Accelerator Laboratory	IL	Fermi			✓			✓
10 Fernald Environmental Management Project	OH	FEMP	✓	✓	✓			
11 General Atomics	CA	GA		✓				
12 General Electric Vallecitos Nuclear Center	CA	GE		d	d			
13 Grand Junction Projects Office	CO	GJPO		✓				
14 Hanford Site	WA	Hanford	✓	✓	✓	✓	✓	✓
Idaho National Engineering Laboratory	ID	INEL	✓	✓	✓	✓	✓	✓
15 Idaho National Engineering Laboratory	ID	INEL		e	e	e	e	e
16 Argonne National Laboratory-West	ID	ANL-W		e	e	e		
17 Naval Reactor Facility	ID	NRF			e			
18 Kansas City Plant	MO	KCP		✓	✓			✓
Knolls Atomic Power Laboratory	NY	KAPL		✓	✓			
19 Knolls Atomic Power Laboratory (Kesselring)	NY	KAPL-K		e	e			
20 Knolls Atomic Power Laboratory (Niskayuna)	NY	KAPL-N		e	e			
21 Knolls Atomic Power Laboratory (Windsor)	CT	KAPL-W		e	e			
22 Laboratory for Energy-Related Health Research	CA	LEHR		✓				
23 Lawrence Berkeley Laboratory	CA	LBL		✓	✓	✓		
Lawrence Livermore National Laboratory	CA	LLNL	✓	✓	✓	✓		✓
24 Lawrence Livermore National Laboratory	CA	LLNL		e	e	e		c
25 Sandia National Laboratories (California)	CA	SNL-CA		e	e			
26 Los Alamos National Laboratory	NM	LANL	✓	✓	✓	✓		✓
27 Mare Island Naval Shipyard	CA	Mare Is		✓	g			
28 Middlesex Sampling Plant	NJ	Middlesex		d				
29 Mound Plant	OH	Mound		✓	✓	✓		
30 Nevada Test Site	NV	NTS	✓	✓	✓	✓		
31 Norfolk Naval Shipyard	VA	Norfolk		✓	g			

Table 1.6–1. Waste Management Sites—Continued

Sites	State	Symbol	Major Site[a]	Waste Type Managed				
				LLMW	LLW	TRUW	HLW	HW[b]
Oak Ridge Reservation	TN	ORR	✓	✓	✓	✓		✓
32 K-25 Site	TN	K-25		e	e			e
33 Oak Ridge Institute for Science and Education	TN	ORISE			e			
34 Oak Ridge National Laboratory	TN	ORNL		e	e	e		e
35 Y-12 Plant	TN	Y-12		e	e			e
36 Paducah Gaseous Diffusion Plant	KY	PGDP	✓	✓	✓	✓		
37 Palos Forest (Site A/Plot M)	IL	Palos		d	d			
38 Pantex Plant	TX	Pantex	✓c	✓	✓			✓
39 Pearl Harbor Naval Shipyard	HI	Pearl H		✓	g			
40 Pinellas Plant	FL	Pinellas		✓	✓			
41 Portsmouth Gaseous Diffusion Plant	OH	PORTS	✓	✓	✓			
42 Portsmouth Naval Shipyard	ME	Ports Nav		✓	g			
43 Princeton Plasma Physics Laboratory	NJ	PPPL		✓	✓			
44 Puget Sound Naval Shipyard	WA	Puget So		✓	g			
45 RMI Titanium Company	OH	RMI		✓	✓			
46 Rocky Flats Environmental Technology Site	CO	RFETS	✓	✓	✓	✓		
Sandia National Laboratories	NM	SNL-NM	✓c	✓	✓	✓		✓
47 Sandia National Laboratories (New Mex)	NM	SNL-NM		e	e	e		e
48 Inhalation Toxicology Research Institute	NM	ITRI		e	e			
49 Savannah River Site	SC	SRS	✓	✓	✓	✓	✓	✓
50 Stanford Linear Accelerator Center	CA	SLAC			✓			
51 University of Missouri	MO	UofMO		✓		✓		
52 Waste Isolation Pilot Plant	NM	WIPP	✓			f		
53 Weldon Spring Site Remedial Action Project	MO	WSSR		d	d			
54 West Valley Demonstration Project	NY	WVDP	✓c	✓	✓	✓	✓	
Total sites			17	37	27	16	4	11

Notes: ✓ = the facility is included in the indicated group. A site is listed under a waste type if it currently manages or is expected to manage that type of waste in the future. Joint DOE/Navy Nuclear Propulsion Program sites are: Bettis, Charleston, KAPL-K, KAPL-N, KAPL-W, Mare Is, Norfolk, NRF, Pearl H, Ports Nav, and Puget So. Former FUSRAP (Formerly Utilized Sites Remedial Action Program) sites are Colonie and Middlesex.

[a] "Major" sites are those that are the focus of the WM PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite; (2) they are candidates to host disposal facilities; (3) they manage HLW; or (4) they were included to be consistent with the Federal Facility Compliance Act process.

[b] Sites analyzed in the WM PEIS are those 11 sites that generated more than 90% of DOE's HW for the year 1992. Other DOE sites also manage HW but were not evaluated. Naval Nuclear Propulsion Program sites were not considered in the WM PEIS analysis for HW.

[c] Although this site is designated as a major site, none of the alternatives would result in wastes from other sites being shipped to this site for treatment or disposal.

[d] The site is included in the table because it is listed in data sources for LLMW; however, no programmatic waste management decision would be applicable to the site. Since it is managed as an environmental restoration site, it is excluded from the WM PEIS alternatives and waste totals.

[e] For evaluating candidate sites for waste management facilities in this WM PEIS: ANL-W and NRF have been combined with INEL; ITRI has been combined with SNL-NM; K-25, ORISE, ORNL, and Y-12 have been combined under ORR; SNL-CA has been combined with LLNL; and KAPL-K, KAPL-N, and KAPL-W have been combined under KAPL.

[f] TRUW is not currently stored or managed at WIPP. WIPP is a planned disposal site and is included because of its potential to treat TRUW.

[g] Naval shipyards may generate small quantities of LLW; however, they are not reported in the WM PEIS.

of the Idaho National Engineering Laboratory [INEL]; and the location of Sandia National Laboratories-California [SNL-CA], is adjacent to Lawrence Livermore National Laboratory).[5]

Table 1.6-2 lists estimated quantities of LLMW, LLW, TRUW, HLW, and HW to be managed at each of the 54 sites. The values are based on current inventories and projections of generation for a 20-year period. DOE made broad, programmatic assumptions applicable to all sites for the purpose of analysis. These include the assumption that LLMW, LLW, HW, and TRUW would be stored where generated until treatment and disposal. This assumption was not meant to restrict site-specific operations and exceptions where they would not prejudice analysis or decisions.

1.6.1 MAJOR SITES ANALYZED IN THE WM PEIS

Of the 54 sites, 17 were designated major sites in the PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite, (2) they are candidates to host disposal facilities, (3) they manage HLW, or (4) they were included to be consistent with the Federal Facility Compliance Act process. The major sites store or will generate the bulk of the five waste types, have the capability for disposal of LLW or LLMW, or have existing or planned major waste management facilities. The designation of these sites as major has no relevance outside the context of this PEIS analysis. Major and candidate sites were not "preselected" for waste management activities; rather, analysis of potential activities at these sites provides a range of reasonably foreseeable environmental impacts that could arise from treating, storing, and disposing of DOE's wastes. As a result, broad comparisons of potential impacts across sites can be made.

1.6.2 WASTE VOLUMES AT MAJOR SITES

Table 1.6–3 lists the major sites and indicates the current and projected volume of each waste type at each of the sites (WIPP does not currently contain any waste and thus is not included). In addition, the table shows the overall percentage of each type of waste at each site.

[5] The one exception to these groupings based on geographic proximity is the Knolls Atomic Power Laboratories—two in New York and one in Connecticut. Data for these sites were compiled on a collective rather than an individual site basis; therefore, these sites are considered as one site.

Table 1.6–2. Quantities of Waste Material at Waste Management Sites (values in cubic meters except HLW in numbers of canisters)

Site	Major Sites[c]	LLMW[a] Inventory	LLMW[a] 20-Year Projected Generation	LLW[a] Inventory	LLW[a] 20-Year Projected Generation	TRUW[a,b] Inventory	TRUW[a,b] 20-Year Projected Generation	HLW Inventory (Liquid)	HLW Total Canisters Projection	HW 20-Year Projected Generation
Ames		0.3	0.1	26	80					d
ANL-E	✓	34[i]	130[i]	880	5,800	15	1,300			4,100
BCL		0	0.1							d
Bettis		32	16	0	12,000					d
BNL	✓e	85	110	560[i]	5,080[i]					d
Charleston		0.3	3							d
ETEC		3.7	13			0.02	0			d
Fermi				45	1,400					980
FEMP	✓	2,600	48	g	g					d
GA		43	0.4							d
GJPO		0.6	0.9							d
Hanford	✓	3,100	33,000	0	89,000	12,200	39,400	210,000	15,000	6,100
INEL	✓	25,000	9,600	3,500	101,000	38,000	780	10,000	1,700	3,900
INEL[h]		(25,000)	(9,600)	(3,500)	(101,000)	(38,000)	(780)	(10,000)	(1,700)	(3,900)
ANL-W[h]		(16)	(24)	i						d
NRF[h]				h						
KCP		0.8	0	4	20					12,000
KAPL		3.1	220	0	19,000					d
KAPL-K		(2)	(100)							d
KAPL-N		(1)	(80)							d
KAPL-W			(40)							d
LEHR		4	3							d
LBL		6	270	53	1,200	0.8	0.2			d
LLNL	✓	230	4,100	780	2,800	200	1,500			13,000
LLNL[h]		(220)	(4,000)	(730)	(2,500)	(200)	(1,500)			(13,000)
SNL-CA[h]		(11)	(100)	(50)	(280)					d
LANL	✓	670	2,100	0	150,000	8,300	2,500			4,900
Mare Is		10	42							d
Mound		76	4	1,600	37,000	270	1,200			d
NTS	✓	300[i]	2,700[i]	270[i]	1,400[i]	610	0			d
Norfolk		0	6							d
ORR	✓	26,000	33,000	20,000	250,000	2,000	720			5,500
K-25[h]		(11,000)	(16,000)	(15,000)	(162,000)					d
ORISE[h]					(500)					d
ORNL[h]		(3,000)	(9,500)	(3,500)	(26,000)	(2,000)	(720)			d
Y-12[h]		(12,000)	(7,300)	(1,000)	(62,000)					d

Table 1.6–2. Quantities of Waste Material at Waste Management Sites (values in cubic meters except HLW in numbers of canisters)—Continued

Site	Major Sites[c]	LLMW[a]		LLW[a]		TRUW[a,b]		HLW		HW
		Inventory	20-Year Projected Generation	Inventory	20-Year Projected Generation	Inventory	20-Year Projected Generation	Inventory (Liquid)	Total Canisters Projection	20-Year Projected Generation
Pantex	✓[e]	130	560	210[i]	2,440[i]					10,000
Pearl H		2	4							d
PGDP	✓	600	0	5,300	45,000	14	0			d
Pinellas		0.02	0.02	16	1,300					d
PORTS	✓	7,500	25,000	1,500	96,000					d
Ports Nav		0.4	0.8							d
PPPL		0	0.01	2	220					d
Puget So		62	170							d
RMI		22	7	2,500	48,000					d
RFETS	✓	8,300	13,000	2,400	39,000	1,500	4,800			d
SNL-NM	✓[e]	69	33	680	1,800	1	0			3,100
SNL-NM[h]		(66)		(410)	(820)					(3,100)
ITRI[h]		(4)	(33)	(270)	(1,000)					d
SRS	✓	6,600	13,000	11,000	500,000	5,100	12,000	150,000	4,600	5,500
SLAC				2,200	280					d
UofMO		0.4	1.7			0	2			d
WIPP	✓	[illegible]	[illegible]			f	f			d
WVDP	✓[e]	23	32	14,000[i]	28,000[i]	0.5	0	2,200	340	d
TOTAL	17	82,000	137,000	67,500	1,440,000	67,700	64,000	378,000	21,600	69,000

[a] Updated inventories and waste generation rates are summarized in Appendix I - "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW." Most site data reported here have been rounded to two significant figures; therefore, totals may not precisely represent the waste totals as reflected in the following chapters and Appendix I.
[b] TRUW volumes presented in this table include both contact-handled and remote-handled TRUW. In addition, Table 8.1–1 shows in parentheses waste volumes for TRUW inventory as reported in BIR-2 (DOE, 1995i) and the WIPP SEIS-II (DOE, 1996n). Comparison of these values is not necessarily appropriate because the BIR-2 values reflect some level of treatment.
[c] Major sites are those that are the focus of the WM PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite, (2) they are candidates to host disposal facilities, (3) they manage HLW, or (4) they were included to be consistent with the Federal Facility Compliance Act process.
[d] These sites manage HW but were not evaluated. Sites analyzed in the WM PEIS are those sites that generated in total more than 90% of DOE's HW for the year 1992. Volumes include only nonwastewater RCRA-defined waste, which is the focus of this PEIS analysis.
[e] While designated as a major site, none of the alternatives would result in wastes being received from other sites for treatment or disposal.
[f] No waste reported in data sources used in the WM PEIS.
[g] Wastes at these sites are managed as ER wastes.
[h] For evaluating candidate sites for waste management facilities in this WM PEIS, ANL-W and NRF have been combined with INEL; ITRI has been combined with SNL-NM; K-25, ORISE, ORNL, and Y-12 have been combined under ORR; SNL-CA has been combined with LLNL; and KAPL-K, KAPL-N, and KAPL-W have been combined under KAPL.
[i] For purposes of analysis, data for this site were taken from the IDB Report-1994 (DOE, 1995h). See Appendix I, Section I.3, for a comparison of waste volumes between the 1992 IDB and IDB Report-1994.

Table 1.6–3. Volumes and Percent of Waste Management Waste at Major Sites[a]
(total inventory and projected waste loads in cubic meters, except HLW in number of canisters)

Waste Type		ANL-E	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Others
LLMW 99% at 16 sites	219,000	160	190	2,600	36,000	35,000	4,300	2,800	3,000	59,000	600	690	33,000	21,000	100	20,000	55	1,100
	100%	*	*	1%	16%	16%	2%	1%	1%	27%	*	*	15%	10%	*	9%	*	1%
LLW 91% at 15 sites	1,500,000	6,700	5,600		89,000	105,000	3,600	150,000	1,700	270,000	50,000	2,700	98,000	41,000	2,500	510,000	42,000	130,000
	100%	*	*		6%	7%	*	10%	*	18%	3%	*	7%	3%	*	34%	3%	9%
TRUW 99% at 12 sites	132,000	1,300			52,000	39,000	1,700	11,000	610	2,700	14			6,200	1	17,000	0.5	1,500
	100%	1%			38%	30%	1%	8%	0.5%	2%	*			5%	*	13%	*	1%
HLW 100% at 4 sites	21,600 canisters				15,000 canisters	1,700 canisters										4,600 canisters	340 canisters	
	100%				69%	8%										21%	2%	
HW[b] 81% at 9 sites	69,000	4,100			6,100	3,900	13,000	4,900		5,500		10,000			3,100	5,500		13,000
	100%	6%			9%	6%	19%	7%		8%		14%			4%	8%		19%

Notes: * indicates that waste percentage at this site is less than 0.5%. Blank cells indicate no volume for this waste type based on data sources analyzed in the WM PEIS.

[a] Waste volume projections contained in this and other WM PEIS tables may vary from the latest site estimates at the time of publication. Significant variances reported (e.g., ANL-E) have typically been in the conservative direction—the WM PEIS analyses were based on larger waste volumes than are currently projected. Updated inventories and waste generation volumes are summarized in Appendix I, "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW." Table shows 16 of the 17 sites analyzed in detail by WM PEIS. WIPP, the 17th site, does not currently manage waste and is omitted. Site data have been rounded to two significant figures; therefore, totals may not sum to 100% and may not precisely represent the waste totals as reflected in the following chapters.

[b] HW volumes are shown for the 9 major sites managing nonwastewater regulated by RCRA. Other sites also manage HW but were not evaluated. HW volumes are calculated by adding onsite thermal treatment and fuel burning totals with offsite commercial treatment and multiplying the sum by 20 to obtain a 20-year projected inventory. For this PEIS, the conversion factor used is one metric ton of hazardous waste equals one cubic meter in volume.

Sources of data on inventory and projected waste volumes for each of the waste types are listed below and described in detail in the waste type chapters (Chapters 6–10) and Appendix I.

- LLMW—The *Mixed Waste Inventory Report* (DOE, 1994i) was used for all LLMW inventories and generation rates, except for Colonie, ETEC, and RFETS, whose generation rates and inventories come from late 1994 site estimates, and ANL-E and NTS, whose generation rates and inventories come from the updated *Mixed Waste Inventory Report* (DOE, 1995k).
- LLW—The *Integrated Data Base for 1992* (DOE, 1992b) was used for generation rates and inventories of stored waste except for BNL, NTS, ORR, Pantex, and WVDP, whose generation rates and inventories come from the updated *Integrated Data Base Report-1994* (DOE, 1995h). The Waste Management Information System (ORNL, 1992) was consulted for data not available in the Integrated Data Base.
- TRUW—The *Integrated Data Base for 1992* (DOE, 1992b) and the *Interim Mixed Waste Inventory Report* (DOE, 1993) were used for TRUW inventories and generation rates except for Hanford and SRS. SRS generation rates and inventories come from the updated *Mixed Waste Inventory Report* (DOE, 1995k), while Hanford's come from the *WIPP TRUW Baseline Inventory Report (BIR-2) for 1995* (DOE, 1995i).
- HLW—Site-specific plans and NEPA documents for Hanford, INEL, SRS, and WVDP were used for HLW volume and canister production rates.
- HW—The EPA Information System biennial and annual reports (EPA, 1991) were used for HW generation rates. Offsite shipments to commercial treatment were derived from DOE fiscal year 1992 HW shipping manifests.

Waste loads reported in Tables 1.6-2 and 1.6-3, as well as Chapters 6 through 10, represent a "snapshot in time"—accurate to the extent existing inventories and future operations were understood when the databases were developed. Accordingly, inventories and projections reported in Table 1.6-3 and Chapters 6 through 10 may not exactly match projections at the time of publication of the Final WM PEIS.

Factors responsible for the degree of uncertainty in estimating waste loads are discussed in Appendix I, which provides a more recent snapshot of DOE's waste inventory and projections. At selected sites, substantial differences are apparent, reflecting these uncertainties. As described in Appendix I, DOE determined that it was necessary to revise some of the waste load information and associated analyses presented in the WM PEIS on the basis of this more recent information. Additionally, as Appendix I shows, consolidation of waste loads and operations across sites in Regionalized and Centralized Alternatives serves to dampen uncertainty associated with site-specific waste inventories and projections.

Considering these uncertainties, dampening effects, and the selected updates, the waste loads used for the WM PEIS analysis are sufficiently accurate for programmatic decision making.

17 Major Sites Analyzed

Argonne National Laboratory-East
Brookhaven National Laboratory
Fernald Environmental Management Project
Hanford Site
Idaho National Engineering Laboratory
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
Nevada Test Site
Oak Ridge Reservation
Paducah Gaseous Diffusion Plant
Pantex Plant
Portsmouth Gaseous Diffusion Plant
Rocky Flats Environmental Technology Site
Sandia National Laboratories-New Mexico
Savannah River Site
Waste Isolation Pilot Plant
West Valley Demonstration Project

1.7 Scope of the Waste Management Programmatic Environmental Impact Statement

1.7.1 Defining the Scope of the WM PEIS

Initially, the scope of the WM PEIS included both the Department's waste management and environmental restoration programs (DOE, 1994b). Although these programs both address the radioactive and chemical contaminants that are the legacy of the Cold War, they do so in different contexts. Environmental restoration contains or removes contaminants in environmental media such as soil and groundwater; whereas waste management activities include treatment, storage or disposal of wastes that are not part of the environment, such as sludge and liquids stored in tanks. Environmental restoration seeks to clean up past releases of contaminants. Waste management seeks to prevent further releases in the future by treating and disposing of wastes safely. Despite these differences, there is significant overlap between the two programs. They both address many of the same types of contaminants, and to the extent that environmental restoration removes contaminants from the environment, it may create wastes that, in some instances, will be transferred to the waste management program. Because of this overlap, DOE initially attempted to integrate evaluations of alternatives for both programs in the WM PEIS.

As DOE proceeded with preparation of the WM PEIS, however, it concluded that it should not develop or evaluate programmatic alternatives for environmental restoration. The initial decisions DOE must make about environmental restoration are not programmatic or strategic, but specific to its individual sites. These decisions concern the uses to which each site will be put in the future. For the most part, a decision on how one site can or will be used in the future does not depend on how other sites in the complex will be used, but depends instead on such things as the degree of contamination, the applicable cleanup standards, the views of local residents and regulators, DOE's need for the site in the future, and the alternative uses that are feasible for the site. It would not be sensible to evaluate programmatic alternatives for future uses within the DOE complex, because the process of developing alternative uses and selecting among them will, for the most part, proceed at each site as part of cleanups undertaken pursuant to CERCLA and RCRA. For this reason, DOE announced on January 24, 1995, in the *Federal Register* that the scope of the PEIS would be limited to programmatic alternatives concerning where DOE should manage its different types of wastes (DOE, 1995b). Appendix A of this PEIS contains a summary of the comments received in response to DOE's proposal to change the scope and DOE's responses to those comments.

In contrast, it is appropriate to evaluate programmatic alternatives for waste management. There are economies of scale as to environmental impacts and costs that vary according to the degree to which waste management is centralized or dispersed among the sites in the complex. For example, centralized alternatives tend to increase transportation impacts, concentrate potential impacts from effluent and emissions at a few sites, and reduce costs and impacts from construction. Decentralized Alternatives tend to reduce transportation impacts, disperse potential impacts from effluent and emissions among many sites (but may increase the total amount of these impacts for the entire complex), and increase costs and construction impacts. The WM PEIS allows DOE to evaluate these often countervailing economies of scale so that it can decide how much—if at all—it should centralize the management of each of its five types of wastes.

There was one aspect of environmental restoration, however, that appeared suitable for programmatic analysis at the time DOE redefined the scope of the WM PEIS. This analysis would focus on those wastes generated during environmental restoration that would be transferred to the waste management program. The two general approaches to controlling contaminants in environmental media include containment and removal. Removing contaminated media from the environment creates waste. Although DOE plans to manage the majority of these wastes at commercial facilities or at facilities dedicated to the environmental restoration program, it also plans to transfer some of the waste generated during environmental restoration to the waste management program. These wastes, referred to as "environmental restoration (ER) transferred wastes," would be treated, stored, and disposed of in facilities DOE would also use to manage its inventory wastes and wastes generated from ongoing operations, which are collectively referred to as "waste management (WM) wastes."

If DOE had sufficient information about the ER transferred wastes, it would evaluate their impacts in the same manner as the impacts of WM wastes are evaluated in the WM PEIS. Unfortunately, DOE still does not have enough information on the volume or contaminant composition of these wastes to perform a meaningful impact evaluation at this time. The overall volume of ER transferred wastes depends on the extent of environmental restoration at a site, which in turn depends on decisions regarding the future use of the site and the amount of cleanup necessary to permit that use. It also depends on how sites and regulators strike the balance between containment and removal strategies at a site. For example, the more extensive the use of removal actions, the larger the volume of waste generated during environmental restoration. The volume of ER transferred waste also depends on the availability of commercial or environmental restoration facilities. For example, a site with a large volume of ER waste may transfer relatively little of it to the waste management program if commercial or dedicated environmental restoration facilities are available to manage these wastes.

At present, very little information is available to DOE about factors that will determine the volumes of environmental restoration wastes overall and the portion of the wastes that DOE will transfer to the waste management program. DOE lacks this information primarily because the Department and its regulators do not yet know how much environmental restoration is needed at sites or how it will be accomplished. Without this information, it is difficult to predict when and where environmental restoration wastes will be generated during the coming decades. Based on the limited information it does have, DOE has made some preliminary estimates of the volumes of environmental restoration wastes it may generate and the amounts it may transfer to the waste management program. These estimates are discussed in Appendix B.

Additionally, very little information is available to DOE about the composition of environmental restoration wastes. This prevents the Department from evaluating the impacts of managing these wastes at this time. Environmental restoration can produce low-level wastes, low-level mixed wastes, and transuranic wastes. Although DOE has made preliminary estimates about how much of each of these wastes environmental restoration may generate at a particular site, it has almost no information on how chemical or radiological contaminants vary within each of these broad types of environmental restoration wastes. Without this basic information on the nature and composition of these wastes, DOE cannot determine the facilities needed to manage them or the impacts those facilities would have on the environment. Appendix B of the WM PEIS discusses recent estimates of the expected volumes of ER transferred waste and how these wastes may affect waste management facilities.

Faced with these uncertainties about ER transferred wastes, DOE chose to proceed to evaluate programmatic alternatives for managing the WM wastes rather than delay the WM PEIS until detailed information about ER transferred wastes became available. For the following reasons, DOE concluded it would be better to proceed with the WM PEIS despite the uncertainties surrounding environmental restoration transferred wastes.

First, information about ER transferred wastes, particularly about its radiological and chemical composition, may be unavailable until most of DOE's environmental restoration activities are underway. Waiting for this information could delay DOE's decisions on how to treat and dispose of its WM wastes for years or decades. Second, decisions DOE's sites and regulators make about environmental restoration and the use of commercial and dedicated facilities to manage the wastes that cleanup activities generate could greatly reduce the amounts of wastes transferred to the waste management program. This would result in DOE having to postpone improving the management of its existing wastes in order to evaluate a set of wastes that by then might have become insignificant at many sites. Third, the impacts of sending ER transferred wastes to the waste management program are expected to be no more than adding equivalent amounts of waste management wastes, and could be much less because wastes generated during environmental restoration tend to have lower concentrations of chemical and radiological contaminants than WM wastes of the same type. Finally, DOE will have the opportunity to evaluate the impacts of ER wastes on waste management facilities during sitewide or project-level NEPA reviews or during the CERCLA process, which requires an evaluation of alternatives similar to NEPA's.

On the basis of the WM PEIS, DOE will decide which sites will manage its existing wastes and those wastes that DOE will generate in its ongoing operations. Regardless of the amount of ER transferred wastes that DOE may generate in the future, DOE needs to select the sites at which it will manage the WM wastes and, to the extent necessary, begin planning and building additional facilities it needs for these wastes. These new facilities will require additional NEPA analyses before DOE can decide where they would be located at a site, what technologies they would use, how they would be operated, how their adverse impacts would be mitigated, and what would be reasonable alternatives to the proposed facility. If at the time DOE conducts these analyses it proposes to use the facility for both ER transferred wastes and WM wastes, the Department can develop reasonable alternatives that incorporate more recent information about the specific ER transferred wastes it proposes to send to that facility. On the other hand, if DOE decides not to send ER transferred wastes to a waste management facility (either because such a facility is not available or because there is still insufficient information about the wastes), DOE would have to evaluate at some time — under either NEPA or CERCLA — the reasonable alternatives for managing these wastes, which could include building a new facility dedicated to handling these wastes, modifying an existing facility, or sending them to a commercial facility.

While DOE determined that environmental restoration decisions, including the level of site remediation should be made on a site-specific basis, some national perspective and public participation is needed. Public input can guide consistency in site-specific decisions, weigh equity trade-offs between sites, and ensure an adequate level of protection and financial controls.

DOE has begun a "National Dialogue" initiative to provide a means for comprehensive discussion with governmental officials, regulatory authorities, and other interested organizations and publics regarding the major materials, waste, and cleanup decisions DOE needs to make. This dialogue will include public participation and input on national environmental restoration issues.

1.7.2 Public Involvement Related to the Draft WM PEIS

Before release of the Draft WM PEIS, DOE expanded its outreach efforts to focus on public awareness of its revised scope. These efforts included briefings to groups such as the Environmental Management Advisory Board and the Site Specific Advisory Board chairpersons, participation in quarterly public meetings at several sites, wide distribution of a WM PEIS Update newsletter, and the release of a video describing the WM PEIS. On September 22, 1995, DOE published a *Federal Register* notice announcing the release of the Draft WM PEIS and invited the public to comment on the document during the 90-day public comment period (September 22 through December 21, 1995). Opportunities to comment were provided in a series of 13 video conference hearings held from October 17, 1995, through January 24, 1996. Several of these video conferences linked multiple DOE sites together with DOE Headquarters; altogether, 18 locations were involved in the hearings.

The video conference hearing format was used to provide a wider opportunity for Headquarters' participation, allow an interactive meetings approach, and reduce costs. The public hearings were advertised through local newspapers, morning and evening drive-time radio announcements, and other mechanisms such as direct mailings to interested members of the public, meeting announcements to active groups or advisory boards, and additional advertising as deemed necessary by the DOE site representatives. Public comments collected at the hearings were summarized in the *Draft WM PEIS Hearing Summary Report: A Compilation of Public Hearing Summaries* and placed in DOE public reading rooms in early

February 1996. Comments were also received from the public and other interested parties directly through the mail.

During the public comment period for the Draft WM PEIS, more than 1,200 individuals, states, tribal nations, agencies, and organizations provided DOE with comments. Comments were received from virtually all of the communities near DOE sites identified as "major" in the PEIS, and from many other interested publics. Many citizens and organizations posed questions, comments, or objections regarding proposed waste management activities at particular DOE sites. Some suggested other alternatives for waste management activities; others expressed their preferences for the alternatives described in the PEIS. A few commenters thought that DOE should prepare one comprehensive environmental impact statement on all of its activities; some expressed their support for DOE's current efforts.

One recurring and controversial issue raised during the public comment period was potential human health impacts of treatment, storage, and disposal of the five waste types. The concerns raised included the risk assessment methodologies (e.g., models and assumptions) used in the analysis, risks to densely populated areas or minority and low-income populations, risks associated with subsistence fishing in some communities, transportation risks, impacts on future generations, and additional exposure to populations affected by other DOE nuclear activities.

Commenters challenged DOE's designation of particular sites as "major" sites in the PEIS and requested that these sites be removed from consideration. Related to this issue were comments regarding the accuracy of current waste loads at particular sites.

DOE also received comments and questions on the relationship of the WM PEIS to other DOE programs or projects; the perceived inconsistency of the PEIS with other DOE documents; other waste types or radioactive materials not analyzed in the PEIS; waste management technologies, particularly for waste treatment; the decision criteria DOE will use in making its waste management decisions; the future availability of geologic repositories at Yucca Mountain, Nevada, and the Waste Isolation Pilot Plant in New Mexico; and DOE credibility. Many commenters questioned DOE's February 1995 decision to separate environmental restoration decisions from the scope of the PEIS.

Several commenters offered comments on policies or Federal programs not specifically related to this PEIS, including suggestions to eliminate the production of radioactive and hazardous waste by eliminating certain DOE defense- and energy-related programs.

All comments were carefully considered by DOE. DOE made substantial changes to the Draft WM PEIS as a result of the comments and prepared the Comment Response Document, Volume V of this Final PEIS, to respond specifically to the comments received. In general, public comments, coupled with consultations with commenting agencies and state and tribal governments, resulted in additional analyses, clarification or correction of facts, or expanded discussion in several technical areas. The Comment Response Document provides an explanation of why certain comments did not warrant further change to the PEIS.

In response to the comments received, DOE made the following major changes to the PEIS.

- DOE modified the Decentralized Alternative for HW to replace LANL with INEL as a candidate site for onsite treatment of hazardous waste. This change recognizes the HW treatment capacity that exists at INEL but does not currently exist at LANL. The HW Decentralized Alternative remains the same for purposes of this programmatic analysis (treatment of HW at three sites). Thus, replacement of LANL with INEL does not constitute a substantial change in the proposed action or alternative.
- With respect to information on waste loads, DOE prepared a new appendix, Appendix I, which presents updated waste volume inventories and projections for all waste types. Further, Appendix I provides site-specific comparisons with earlier inventories and projections upon which the analysis in the Draft WM PEIS was based to determine if any of the more recent data would substantially change any of the impacts described in the Draft WM PEIS. Subsequently, DOE performed new analyses using the more recent data at selected sites for LLMW, LLW, TRUW, and HLW. The results of these additional analyses are contained in the relevant chapters.
- DOE modified its analysis of environmental justice concerns to provide a more precise analysis of whether high and adverse human health impacts could disproportionately affect a minority or low-income population. The maps illustrating the proximity of these populations around the major DOE sites have been improved and moved from the former Appendix I (in the Draft WM PEIS) to Appendix C of the Final WM PEIS. DOE performed additional analyses of the potential for offsite general population risk as a result of the disposal of LLMW and LLW. With respect to transportation impacts, DOE clarified the comparison of radiological risks in truck and rail transportation and included the potential number of shipments that would enter and exit each site. DOE also reiterated that the intersite routes used in the analysis are representative of possible routes, not descriptive of actual routes to be used, as the WM PEIS Records of Decision will not select transportation routes.
- DOE revised Chapter 11, "Cumulative Impacts," to provide a more comprehensive evaluation of other DOE actions (e.g., tritium supply and recycling, weapons material stockpile stewardship and management, and storage and disposition of excess fissile materials) that may affect the sites. In this

chapter, DOE also included estimates of fatalities that result from implementation of the alternatives in the absence of mitigation measures and clarified the analytical assumption concerning commingling of groundwater contaminated by releases from different disposal units.

Other substantive changes to the Draft WM PEIS include: an enhanced description of the decisions to be made by DOE (Section 1.7.3, which also consolidates decision criteria information from former Section 1.8); a statement clarifying DOE's compliance with state and local laws and a narrative on relevant DOE orders (Section 1.4); a more comprehensive discussion of site treatment plans, pollution prevention, and other DOE actions and programs (Section 1.8.2); a discussion of privatization (Section 1.7.4); a discussion of safeguards and security (Section 4.3.12); an enhanced discussion of interpreting risk values (Section 5.4.1); and an explanation as to why the No Action Alternatives for some wastes have smaller potential impacts than other alternatives (Sections 6.3.1, 7.3.1, and 8.3.1). DOE has also made other suggested changes to improve readability, including a short Readers' Guide at the beginning of Volume I, commonplace examples to demonstrate waste volumes, and a table for converting waste volumes to both cubic meters and cubic yards. The Final WM PEIS includes an updated list of preparers in Chapter 13.

1.7.3 DOE Waste Management Decisions

In accordance with its NEPA regulations, DOE can prepare three tiers of NEPA reviews: programmatic, sitewide, and project-level. These tiers represent a hierarchy in which broad and general programs and policies can be addressed in an initial programmatic NEPA review. Subsequent NEPA reviews could then analyze narrower proposals related to the program or policy. First-tier programmatic reviews, such as the WM PEIS, provide environmental evaluations for consideration in making decisions on broad agency actions, such as the adoption of new strategies, programs and policies to guide future actions. Sitewide NEPA reviews provide the opportunity for considering changes in the overall operations of a DOE site, including mission changes, and provide a current environmental baseline at the site, both to support and simplify project-level NEPA reviews. Project-level NEPA reviews evaluate the impacts of a specific project at specific locations at a site and are intended in part to provide environmental information on the impact of siting, constructing, and operating a facility. Sitewide NEPA reviews, which evaluate projects that could be implemented in the near-term at a site, may also serve as project-level NEPA reviews if projects can be evaluated sufficiently in the sitewide review. Project-level or sitewide NEPA reviews are generally more focused than programmatic NEPA reviews with regard to detailed site parameters.

In addition, compliance agreements and permitting requirements may require more detailed assessments of technologies prior to their implementation at a site. Project-level and sitewide NEPA reviews that address specific impacts at a site may, therefore, also evaluate the impacts of alternative technologies based on site-specific performance standards that differ from the representative technologies considered in this PEIS. Sitewide and project-level NEPA reviews may also consider more detailed waste characteristics and volumes, including waste from environmental restoration activities. These NEPA reviews may also consider the role that pollution prevention will play in minimizing the wastes under consideration.

In addition to preparing sitewide or project-level NEPA reviews tiered from the WM PEIS, DOE may also rely upon reviews that have already been completed. Existing sitewide and project-level NEPA analyses will be reviewed to determine whether modifications are needed to implement the decisions based on evaluations in the WM PEIS.

With the end of the Cold War, DOE's mission has shifted from an emphasis on nuclear weapons production to cleanup of contamination and disposal of the war's legacy of radioactive and hazardous wastes. Before the Department expends resources to establish new treatment, storage, and disposal facilities at every site where these wastes exist, it is prudent to determine whether to consolidate such functions at fewer sites to reduce costs and potential environmental impacts.

DOE will use the analyses presented in the PEIS to decide on a programmatic or strategic approach to managing its waste. DOE intends to select a configuration of DOE sites for waste management activities on the basis of the WM PEIS and other factors. The level of analysis in the WM PEIS is appropriate for making broad programmatic decisions on what DOE sites should be used for waste management. At the programmatic level, however, it is not possible to take into account special requirements for particular waste streams, different technologies that are or may be available to manage particular wastes, or site-specific environmental considerations such as the presence of culturally important resources or endangered species at a specific location on a site. DOE will rely upon other NEPA reviews, primarily ones that evaluate particular locations on sites or projects (sitewide or project-level reviews), for these analyses. Thus, decisions regarding specific locations for waste management facilities at DOE sites or the waste management technologies to be used will be made on the basis of sitewide or project-level NEPA reviews.

The WM PEIS analyzes four broad categories of alternatives that represent the range of reasonable alternatives concerning where DOE can manage its wastes. Within these broad categories of alternatives (No Action or "status quo," Decentralized, Regionalized, and Centralized), DOE developed different configurations or sets of DOE sites that could be used for waste management activities. The sites identified in each alternative configuration were selected for evaluation based on the volume of waste they currently had in inventory, the amount of waste they were expected to generate in the future, the waste's origin and characteristics, and the waste treatment facilities at each site. DOE then analyzed the potential environmental impacts associated with the waste management activities under each alternative configuration for each waste type, which allowed DOE to assess and compare the alternatives. The WM PEIS describes the results of those analyses for use by the public and DOE's decision makers.

Because the locations of potential facilities cannot be determined at this time, some impacts that are inherently location-specific could not be assessed in this programmatic analysis. For example, the effects of construction of a waste treatment facility on a particular aspect of the environment may be significant if the facility were built at a certain location, and may be easily mitigated or eliminated if the facility were elsewhere. Such effects may include impacts on geology and soils, noise and aesthetic impacts, impacts on species and habitats, and impacts to land use and cultural resources. Although a number of these site-specific impacts are discussed in this PEIS in Chapters 6 through 10, they can be analyzed thoroughly only in sitewide or project-level NEPA reviews. DOE anticipates that, in the majority of cases, any such impacts found to be significant can be mitigated or eliminated by alteration of a proposed facility's location or by other changes.

This PEIS is intended to provide environmental information to assist DOE in determining where it should modify existing waste management facilities or construct new facilities. The types of facilities evaluated in this PEIS are:

- Treatment and disposal facilities for LLMW
- Treatment and disposal facilities for LLW
- Treatment and storage facilities for TRUW
- Storage facilities for treated (vitrified) HLW canisters until a geologic repository is available
- Treatment facilities for nonwastewater HW

LLMW. The evaluation of alternatives for managing LLMW in this PEIS was coordinated with the development of STPs that were prepared pursuant to the FFCAct. Information on possible alternatives, preliminary risk analyses, and cost studies was shared with the States to provide information for use in developing STPs. Although the Draft PEIS analyzed potential environmental risks and costs associated with a range of management alternatives for LLMW in the context of NEPA, decisions on LLMW treatment are made by the States and EPA under the FFCAct. This Final WM PEIS is being released after EPA or authorized State agencies issued orders implementing most of the STPs. DOE will issue Records of Decision on the treatment and disposal of LLMW, explaining what decisions were made by the States and EPA and what alternatives were considered.

LLW. There is no regulatory requirement or timetable for LLW decisions. However, managing LLW is closely tied to the management of LLMW. Accordingly, DOE expects to issue a Record of Decision with respect to LLW in conjunction with its Record of Decision on LLMW management. As a result of a recommendation by the Defense Nuclear Facilities Safety Board (DNFSB)—identified as recommendation DNFSB 94-2—DOE has undertaken a review of the LLW management program across the nuclear weapons complex. This includes review of the regulatory structure for the program as well as an assessment of current operating facilities. Activities conducted in this effort were coordinated with analyses in the WM PEIS.

TRUW. DOE will decide where to treat and store TRUW based on evaluations in the WM PEIS and the requirements of the FFCAct because much of DOE's TRUW is also mixed waste. DOE needs to decide where to treat TRUW if treatment is deemed necessary before disposal at WIPP or some other form of disposition. The final acceptance criteria for TRUW disposal at WIPP are expected to be determined in 1997; at that time, DOE will need to be able to define necessary treatment requirements and select sites for treatment facilities. DOE will also decide where to store treated TRUW on the basis of the PEIS, a decision it must make regardless of whether or when WIPP opens.

HLW. In 1996, DOE began treating HLW at SRS and WVDP. DOE has also entered into an agreement with the State of Washington and EPA to begin treatment of HLW at the Hanford Site in 2009. DOE agreed with the State of Idaho to begin treating the HLW stored in tanks at INEL in 2014. DOE needs to decide where to store treated HLW until it can be permanently disposed of in a geologic repository.

HW. DOE's program for treatment of HW is well established and has been operating for some time. There is existing capacity in the commercial market for HW treatment, storage, and disposal. Accordingly, DOE will decide whether to continue its reliance on commercial vendors or to treat HW at selected DOE sites.

Preferred Alternatives. DOE has identified its preferred alternative for each waste type in Section 3.7. These alternatives were selected on the basis of factors and criteria developed after considering public comments and other available information. The factors and criteria DOE used to select preferred alternatives are described below, in alphabetical order:

Factor:	Criteria:
Consistency	Favors alternatives that are consistent with other complexwide studies using methodologies that allow valid comparisons across sites.
Cost	Favors alternatives that have the potential to minimize overall cost for implementation of selected waste management strategies.
Cumulative Impacts	Favors selection of alternatives and sites that minimize cumulative adverse environmental impacts resulting from other activities at the site.
DOE Mission	Favors alternatives that further the Department's mission to safely and efficiently treat, store, and ultimately dispose of wastes.
Economic Dislocation	Favors alternatives that tend to minimize economic dislocation such as job losses.
Environmental Impact	Favors selection of alternatives and sites that minimize adverse environmental impacts.
Equity	Favors alternatives that distribute waste management facilities in ways that are considered equitable.
Human Health Risk	Favors alternatives that reduce human health risk to both workers and the public. Human health risks depend not only upon the magnitude of releases of radionuclides and hazardous chemicals, but also upon parameters such as population surrounding the sites, the hydrogeology of disposal sites, and the number of vehicle accidents that are expected to occur during transportation of waste.
Implementation Flexibility	Favors alternatives that maximize DOE's ability to modify activities at selected sites as circumstances change, e.g., to potentially manage large volumes of ER wastes.
Mitigation	Favors alternatives that increase DOE's ability to mitigate adverse impacts and that reduce the cost of mitigation.

Regulatory Compliance	Favors alternatives that comply with regulatory requirements, DOE Orders, and commitments made under the FFCAct or in compliance agreements with States and other regulators.
Regulatory Risk	Considers the potential for changes in statutes and regulations when evaluating alternatives and siting options.
Site Mission	Favors alternatives that are consistent with site capabilities and feasible for each waste type, particularly capacities and availability of technologies for treatment, storage, and disposal.
Transportation	Favors alternatives that balance the amount of transportation needed to transport wastes to the sites considered in the alternatives with potential environmental and human health risks, vehicle accidents, public concerns, mission needs, and costs.

Programmatic Decisions. The preferred alternatives are not decisions. Rather, they are the Department's preliminary preferences, which are subject to further discussion and deliberation. No sooner than 30 days after the issuance of this WM PEIS, DOE will begin to make decisions regarding each waste type, using the factors and criteria described above and the evaluations in the WM PEIS. DOE will issue a Record of Decision that will explain the decisions DOE made, why it made these decisions, and what alternatives it considered.

Decisions on waste management sites will be based on the information and analyses in the WM PEIS and other considerations such as regulatory compliance, budget constraints, schedules, compliance with regulatory agreements, including public input on each of the preferred alternatives for each waste type, national priorities, and other DOE studies. For example, DOE will continue to work with the DOE Disposal Workgroup and with state representatives in the National Governors Association to evaluate and discuss the issues related to the potential disposal of residuals from treatment of LLMW at sites subject to the FFCAct. DOE will work with interested members of the public and the National Governors Association to explore principles that may help DOE in making decisions that reflect public concerns.

Site-Specific Decisions. The Records of Decision issued on the basis of the WM PEIS will identify sites at which waste management activities will occur. However, a decision on the specific technology and the particular location of a waste management facility at a site will be made on the basis of sitewide or project-level NEPA reviews "tiered" from this PEIS.

1.7.4 USE OF COMMERCIAL OR PRIVATIZED FACILITIES

Helping the Private Sector

In April 1995, States asked DOE to consider treating mixed waste generated by public and private entities for which no commercial treatment capacity is available. DOE and the National Governor's Association/Federal Facility Compliance Act Task Force are addressing this issue. States would first need to satisfy several specific DOE conditions before DOE would proceed with such a plan. This "privatization in reverse" would deal with a very small volume of waste (less than 200 cubic meters) and therefore would not affect programmatic alternatives evaluated in this PEIS.

For purposes of the WM PEIS, a "commercial facility" is defined as one that is owned and operated by a private entity (or a State) and that treats, stores, or disposes of waste from a variety of sources for a fee. Commercial facilities are generally constructed in response to market forces. Commercial facilities are currently available for the treatment and disposal of LLMW, LLW, and HW. DOE expects that the capacity of commercial facilities to treat and dispose of LLMW and LLW will increase in the future in response to increasing demand from the private sector, DOE, and other government agencies. No commercial management of TRUW or HLW currently exists or is anticipated.

At present, DOE uses commercial facilities for the management of HW, LLW and LLMW. DOE's most extensive and prolonged use of commercial facilities is for treatment of HW. For a number of years, the Department has routinely sent nonwastewater HW to commercial facilities. The WM PEIS analyzes the alternative of using DOE facilities for treatment of this category of HW so that the Department can make an informed programmatic decision on whether to continue to use commercial facilities for this purpose. DOE's use of commercial facilities for management of LLW and LLMW is more limited at present, and much of the LLW and LLMW that DOE currently ships to commercial facilities for treatment or disposal consists of environmental restoration wastes rather than wastes from the Department's waste management program. As noted above in Section 1.7.1, environmental restoration wastes are outside the scope of the WM PEIS because DOE has concluded that it would be inappropriate to make programmatic decisions concerning their management.

Much of the LLMW that DOE sends to commercial facilities for treatment is subject to agreements and orders under the FFCAct. Under this Act, Federal and State authorities made decisions regarding treatment of LLMW on the basis of the site treatment plans prepared by the Department, and these plans contain detailed descriptions of the commercial treatments that DOE currently uses. DOE also uses a commercial facility for disposal of LLMW after treatment. At present, DOE's use of commercial facilities for managing LLW is even more limited than its use of them for LLMW management.

In contrast to the term "commercial facility," the WM PEIS uses the term "privatized facility" to refer to a waste management facility owned by the Department on a DOE site that is operated, maintained, and eventually decontaminated and decommissioned by a private entity. The private entity operates the waste management facility for the exclusive use of DOE, and is reimbursed by the Department on a competitive, fixed-price basis. The term also refers to situations in which a private entity finances, constructs and operates a new waste management facility on a DOE site.[6] For example, the Department is privatizing treatment of some HLW at the Hanford Site; a private entity also operates a LLMW vitrification facility at SRS. There is the potential for DOE to use privatized facilities to manage all five types of waste in the future.

Many DOE sites are exploring opportunities to make greater use of commercial facilities for the treatment and disposal of LLMW and LLW. The WM PEIS does not analyze alternatives that involve extensive use of commercial facilities for managing these two waste types for several reasons.[7] First, DOE's current use of commercial facilities to manage these wastes is limited, and the potential for expanding the use of these facilities in the future is unclear at this time. In particular, DOE cannot predict where new commercial facilities would be located in relation to DOE's sites, what waste streams they would manage, or what their capacity might be. More importantly, DOE does not anticipate that it will make programmatic decisions regarding the use of commercial facilities to manage LLMW and LLW. Instead, each DOE site will decide the extent to which it will use commercial facilities based on the wastes it needs to manage, the capacities and capabilities of the commercial facilities available to the site, and the advantages these facilities offer in comparison to other alternatives, such as using facilities at DOE sites. Sites considering the use of commercial facilities for managing LLMW or LLW may need to include alternatives with such facilities

[6] Outside of the context of the WM PEIS, the term "privatization" is often used to refer to the use of all types of waste management facilities operated by the private sector, including "commercial facilities" as defined in the WM PEIS and facilities constructed and operated by the private sector for the exclusive use of DOE at locations other than DOE's sites.

[7] At this time, the commercial facilities DOE primarily uses for treatment of LLMW include DSSI and SEG in Tennessee and Envirocare in Utah. Envirocare is the only commercial disposal facility for LLMW presently in operation, and DOE sends LLMW to this facility for disposal as well as treatment. The commercial facilities to which DOE currently sends LLW for treatment include SEG and US Ecology in Tennessee and Permafix in Florida. The Department also sends some LLW to commercial facilities for disposal. The vast majority of this goes to Envirocare; a small amount is shipped to the Barnwell Disposal Site in South Carolina. DOE's current use of commercial facilities to manage LLMW and LLW is not explicitly analyzed in the WM PEIS because DOE's present use of these facilities is limited and much of that use is for wastes already analyzed in existing CERCLA or NEPA reviews or is for wastes subject to orders or consent agreements issued by State and Federal regulators under the FFCAct.

in sitewide, project-level, or other NEPA reviews before making a decision on whether to use commercial options. Sites may be able to incorporate aspects of the analyses in the WM PEIS in these reviews. For example, the WM PEIS analyzes the potential transportation impacts associated with shipments of LLMW and LLW; this analysis applies to representative routes and is based on the amounts of waste involved, the number and distance of shipments through representative communities, and the radiological or chemical profile of the waste. Accordingly, the transportation analyses in the WM PEIS may be applicable to some shipments between DOE sites and commercial facilities. Sites may be able to use other aspects of the WM PEIS in any additional NEPA reviews that evaluate the use of commercial facilities to manage LLMW or LLW.

With respect to privatized facilities, the analyses in the WM PEIS would be directly applicable to such facilities located on DOE sites because the impacts of using a privatized facility would be the same as using a DOE facility at that site. Therefore, the alternatives in the WM PEIS include the option of using privatized facilities at the DOE sites analyzed in the WM PEIS.

1.8 WM PEIS Relationship to Other Actions and Programs

1.8.1 Relationship to Other NEPA Reviews and Decisions

Several NEPA documents have been completed recently, are ongoing, or have been proposed that are related to this PEIS. Table 1.8–1 lists these documents, and the following sections briefly discuss the relationship of these documents to this PEIS. Where these other NEPA reviews have identified impacts that could add to the impacts identified in the WM PEIS, these impacts were included in the analysis of cumulative impacts in Chapter 11.

The priorities of DOE have shifted away from nuclear weapon production as discussed in Section 1.2, and the documents referenced in Table 1.8–1 reflect DOE's new and redirected missions. These documents describe selected proposed actions that are important to our nation's defense and energy needs. Consequently, an integrated waste management strategy will remain important to DOE.

Among the actions identified in the following sections, DOE is preparing project-level and site specific NEPA documents that consider waste management facilities in parallel with the preparation of this PEIS.

These parallel NEPA efforts will help to expedite compliance with site-specific agreements and orders issued pursuant to the FFCAct. Prior to reaching decisions on whether to construct waste management facilities evaluated in project-level and sitewide NEPA reviews, DOE will first determine, on a case-by-case basis, whether the implementation of waste management facilities would proceed in accordance with 40 CFR 1506.1(c), which states:

> While work on a required program environmental statement is in progress and that action is not covered by an existing program statement, agencies shall not undertake in the interim any major Federal action covered by the program which may significantly affect the quality of the human environment unless such action (1) is justified independently of the program; (2) is itself accompanied by an adequate environmental statement; and (3) will not prejudice the ultimate decision on the program. Interim action prejudices the ultimate decision on the program when it tends to determine subsequent development or limit alternatives.

Records of Decision on project-level and sitewide NEPA reviews that may be issued prior to decisions on the WM PEIS will reflect DOE's determinations pursuant to 40 CFR 1506.1. However, once decisions are made as a result of the WM PEIS, prior sitewide or project-level decisions may need to be revisited to assure consistency with the programmatic decisions.

Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS (Volume 1). On June 28, 1993, as an outgrowth of civil litigation, the U.S. District Court for the District of Idaho ordered DOE to prepare a comprehensive, sitewide EIS on the direct and indirect environmental effects of all major Federal actions involving spent nuclear fuel at INEL. Subsequent to this order, DOE decided to expand the scope of the in-progress INEL Environmental Restoration and Waste Management EIS to include the programmatic analysis of spent nuclear fuel alternatives that was being considered for inclusion in the WM PEIS.

In April 1995, DOE issued the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE, 1995e), which evaluated alternatives for managing existing and reasonably foreseeable inventories of spent nuclear fuel through the year 2035. Subsequently, DOE in its Record of Decision (ROD) (DOE, 1995f) decided to regionalize spent nuclear fuel management by fuel type

Table 1.8–1. Major Related NEPA Reviews

Title	Document	Status	Site(s)
Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS (Volume 1)	PEIS (DOE/EIS-0203-F)	Final issued April 1995 ROD May 1995	Hanford Site, Idaho National Engineering Laboratory, Nevada Test Site, Oak Ridge Reservation, Savannah River Site, and other locations
Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS (Volume 2)	EIS (DOE/EIS-0203-F)	Final issued April 1995 ROD May 1995	Idaho National Engineering Laboratory
Tritium Supply and Recycling PEIS	PEIS (DOE/EIS-0161)	Final issued October 1995 ROD December 1995	Idaho National Engineering Laboratory, Nevada Test Site, Oak Ridge Reservation, Pantex Plant, Savannah River Site
Storage and Disposition of Weapons-Usable Fissile Materials PEIS	PEIS (DOE/EIS-0229)	Final issued December 1996	Idaho National Engineering Laboratory, Nevada Test Site, Oak Ridge Reservation, Pantex Plant, Savannah River Site, Los Alamos National Laboratory, Hanford Site, Rocky Flats Environmental Technology Site
Stockpile Stewardship and Management PEIS	EIS (DOE/EIS-0236)	Final issued November 1996	Kansas City Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Nevada Test Site, Y-12 Plant at the Oak Ridge Reservation, Pantex Plant, Sandia National Laboratories-New Mexico, and the Savannah River Site
Sitewide EIS for Continued Operation of the Los Alamos National Laboratory	EIS (DOE/EIS-0238)	In preparation	Los Alamos National Laboratory
Nevada Test Site EIS	EIS (DOE/EIS-0239)	Final issued November 1996 ROD December 1996	Nevada Test Site
Rocky Flats Environmental Technology Sitewide EIS	EIS (DOE/EIS-0257)	Deferred	Rocky Flats Environmental Technology Site
Plutonium Interim Storage EIS for the Rocky Flats Environmental Technology Site	EIS (DOE/EIS-0276)	In preparation	Rocky Flats Environmental Technology Site
Solid Residue Treatment, Repackaging, and Storage EA[a]	EA	FONSI[b]	Rocky Flats Environmental Technology Site
Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site EIS	EIS (DOE/EIS-0277)	In preparation	Rocky Flats Environmental Technology Site

Table 1.8–1. Major Related NEPA Reviews—Continued

Title	Document	Status	Site(s)
Savannah River Site Waste Management EIS	EIS (DOE/EIS-0217)	Final issued July 1995 ROD September 1995	Savannah River Site
Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapons Components EIS	EIS (DOE/EIS-0225)	Final issued December 1996	Pantex Plant, Nevada Test Site, Hanford Site, and Savannah River Site
Defense Waste Processing Facility Supplemental EIS	EIS (DOE/EIS-0082-S)	Final issued November 1994 ROD April 1995	Savannah River Site
Interim Management of Nuclear Materials at the Savannah River Site	EIS (DOE/EIS-0220)	Final issued October 1995 ROD December 1995	Savannah River Site
Tank Waste Remediation System EIS	EIS (DOE/EIS-0189)	Final issued August 1996	Hanford Site
Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Services Center EIS	EIS (DOE/EIS-0226-D)	Draft issued March 1996	West Valley Demonstration Project
Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel EIS	EIS (DOE/EIS-0218)	Final issued February 1996 ROD March 1996	Savannah River Site, Idaho National Engineering Laboratory, plus 10 seaports
Disposition of Surplus Highly Enriched Uranium EIS	EIS (DOE/EIS-0240)	Final issued June 1996 ROD July 1996	Y-12 Site at the Oak Ridge Reservation, Savannah River Site, Babcox and Wilcox–Lynchburg Virginia, Nuclear Fuel Services—Erwin, Tennessee
Hanford Plutonium Finishing Plant Complex EIS	EIS (DOE/EIS-0244)	Final issued May 1996 ROD issued July 1996	Hanford Site
Waste Isolation Pilot Plant Disposal Phase Supplemental EIS	SEIS-II (DOE/EIS-0026-S2)	Draft issued November 1996	Waste Isolation Pilot Plant
Long-Term Management of Depleted Uranium Hexafluoride PEIS	PEIS (DOE/EIS-0269)	In preparation	K-25 Site at the Oak Ridge Reservation, Paducah Gaseous Diffusion Plant, Portsmouth Gaseous Diffusion Plant
Medical Isotope Production EIS	EIS (DOE/EIS-0249)	Final issued April 1996 ROD issued September 1996	Sandia National Laboratories-New Mexico, Los Alamos National Laboratory, Oak Ridge National Laboratory, Idaho National Engineering Laboratory

Table 1.8–1. Major Related NEPA Reviews—Continued

Title	Document	Status	Site(s)
Management of Spent Nuclear Fuel Currently Stored in the K-Basins EIS	EIS (DOE/EIS-0245)	Final issued February 1996 ROD issued March 1996	Hanford Site
Safe Retrieval, Transfer, and Interim Storage of Hanford Tank Wastes EIS	EIS (DOE/EIS-0212)	Final issued October 1995 ROD December 1995	Hanford Site
Hanford Remedial Action EIS and Comprehensive Land Use Plan	EIS (DOE/EIS-0222)	Draft issued August 1996	Hanford Site
Savannah River Site F-Canyon Plutonium Solutions EIS	EIS (DOE/EIS-0219)	Final issued December 1994 ROD February 1995	Savannah River Site
Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories—California EIS	EIS (DOE/EIS- 0157)	Final issued August 1992 ROD issued January 1993	Lawrence Livermore National Laboratory, Sandia National Laboratories-California
Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain EIS	EIS (DOE/EIS-0250)	In preparation	Yucca Mountain, Nye County, Nevada
Evaluating Container Systems for the Management of Naval Spent Nuclear Fuel EIS	EIS[c] (DOE/EIS-0251)	Final issued November 1996	Idaho National Engineering Laboratory
Disposal of Decommissioned, Defueled Cruiser Ohio Class and Los Angeles Class Naval Reactor Plants EIS	EIS[c] (DOE/EIS-0259)	Final issued April 1996 ROD issued July 1996	Hanford
S1C Prototype Reactor Plant Disposal EIS	EIS (DOE/EIS-0275)	Final issued November 1996	KAPL-W

[a] EA = Environmental Assessment.
[b] FONSI, a Finding of No Significant Impact, was determined for this EA.
[c] The Department of the Navy was the lead agency for these NEPA reviews. DOE was a cooperating agency.

at three sites: the Hanford Site, INEL, and the Savannah River Site (SRS) pending disposal in a geologic repository. Under this decision, the fuel distribution would be as follows:

- Hanford production reactor fuel will remain at the Hanford Site.
- Aluminum clad fuel will be consolidated at the SRS.
- Nonaluminum-clad fuels (including spent nuclear fuel from the Fort St. Vrain Reactor and Naval spent nuclear fuel) will be consolidated at INEL.

In addition to regionalizing the management of spent nuclear fuel, DOE also decided to resume the shipments of Naval spent nuclear fuel to INEL immediately, upon the staying or dissolution of an injunction order by the United States District Court for the District of Idaho.

The cumulative impact analysis of the waste management alternatives in Chapter 11 of this PEIS includes the environmental impacts resulting from this decision on spent nuclear fuel management.

Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS (Volume 2). In April 1995, DOE issued Volume 2 of the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE, 1995e), which in addition to evaluating programmatic spent nuclear fuel alternatives, evaluated sitewide alternatives for environmental restoration and waste management programs at INEL. Subsequently, DOE in its ROD (DOE, 1995f) decided to implement the Modified Ten-Year Plan, or the preferred alternative, for INEL as evaluated in the Final EIS. Commensurate with this decision, INEL would accept nonaluminum-clad spent nuclear fuel for management; continue the restoration of priority sites and the stabilization of sites based on health and environmental risks and budget; develop cost-effective waste treatment technologies; and implement projects and facilities to prepare waste and spent nuclear fuel for final disposition and allow more efficient examination of naval spent nuclear fuel.

Implementation of certain projects and facilities for preparing and managing waste at INEL would be subject to further reviews under NEPA and decisions to be reached as result of the WM PEIS. The cumulative impact analysis of the waste management alternatives in Chapter 11 of the WM PEIS includes the environmental impacts resulting from the decision to implement the Modified Ten-Year Plan at INEL.

Tritium Supply and Recycling PEIS. In 1991, DOE was actively considering the reconfiguration of its nuclear weapons complex and proposed to evaluate the environmental consequences of that reconfiguration in a PEIS. In 1994, as a result of reevaluating current and projected future requirements for the nuclear weapons complex in light of a number of recent world and national developments, DOE proposed to divide its previously planned Reconfiguration PEIS into two separate PEISs: a Tritium Supply and Recycling PEIS and a Stockpile Stewardship and Management PEIS (DOE, 1994c). The Tritium Supply and Recycling Final PEIS, issued in October 1995 (DOE, 1995g), evaluates alternatives associated with new tritium production and recycling of tritium recovered from weapons retired from service. The ROD, issued in December 1995, selected the Savannah River Site for tritium production should that technology be adopted, and also for the upgrade and consolidation of tritium recycling activities. The Tritium Supply and Recycling EIS will consider decisions regarding waste management resulting from the WM PEIS

Storage and Disposition of Weapons-Usable Fissile Materials PEIS. The *Storage and Disposition of Weapons-Usable Fissile Materials PEIS* (DOE 1996a) analyzes the environmental impacts of alternatives being considered for the long-term storage of weapons-usable plutonium and highly enriched uranium (HEU), and the disposition of weapons-usable plutonium that has been declared surplus to national security needs. Three alternatives, in addition to the No Action Alternative, are being considered for long-term storage: upgrade at multiple sites, consolidation of plutonium at one site, and collocation of plutonium and HEU at one site. Six sites are being considered for long-term storage: Hanford Site, INEL, NTS, ORR, Pantex, and SRS. All of the alternatives considered the removal of all weapons-usable fissile materials from the RFETS and removal of the surplus fissile materials from the LANL.

There are nine alternatives in three categories being analyzed for the disposition of surplus plutonium. The three disposition categories are "deep borehole," "immobilization," and "burn in reactors." For disposition, decisions will be made on the strategy and technologies for disposition of surplus weapons-usable plutonium. Until other environmental analyses are completed, no specific location will be selected for any disposition alternative action (DOE, 1996a).

Any waste type resulting from actions taken in the Storage and Disposition PEIS would be treated, stored, and disposed of in accordance with the decisions resulting from the WM PEIS. There is no expectation that the storage and disposition actions will result in a waste form that is not addressed in the WM PEIS.

In the event that the "burn in reactors" option is selected, any resultant spent fuel would be disposed of in accordance with the Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain EIS (see narrative).

Stockpile Stewardship and Management PEIS. Stockpile stewardship refers to activities associated with research, design, development, and testing of nuclear weapons and the assessment and certification of the safety and reliability. The stockpile stewardship portion of the PEIS evaluates the potential impacts of three proposed facilities: the National Ignition Facility, the Contained Firing Facility, and the Atlas Facility. The Stockpile Stewardship alternatives involving these facilities could affect four sites: LANL, LLNL, SNL, and Nevada Test Site (NTS) (DOE, 1996b).

Stockpile management refers to activities associated with the production, maintenance, surveillance, refurbishment, and dismantling of the nuclear weapons stockpile. The stockpile management portion of this PEIS evaluates the potential impacts of carrying out Stockpile Management Alternatives at eight sites: Oak Ridge Reservation (ORR), SRS, Kansas City Plant (KCP), Pantex Plant, LANL, LLNL, SNL, and NTS. The Management Alternatives are assessed for nuclear weapons assembly/disassembly and for fabricating pits, secondaries and cases, high explosives, and nonnuclear components. The Stockpile Stewardship and Management PEIS also evaluates the No Action Alternative of relying on existing facilities in their current configuration and continuing the missions at current sites to achieve both the stockpile stewardship and management missions.

DOE has identified the preferred alternatives in the final *Stockpile Stewardship and Management PEIS*. The preferred alternatives for the stockpile stewardship portion of the PEIS include the construction and operation of the National Ignition Facility and Contained Firing Facility at LLNL and the construction and operation of the Atlas Facility at LANL. The preferred alternative for the stockpile management portion includes secondary and case component fabrication at ORR, pit component fabrication at LANL, assembly and disassembly and high explosives fabrication at Pantex, and nonnuclear component fabrication at KCP. The *Stockpile Stewardship and Management PEIS* also includes the preferred alternative for strategic reserve storage; however, this may change based upon decisions to be made with regard to the final *Storage and Disposition of Weapons-Usable Fissile Materials PEIS*.

Evaluation of impacts on waste management is included in the assessment, and wastes generated as a result of the stockpile stewardship and management activities are compatible with treatment, storage, and disposal decisions resulting from the WM PEIS.

Sitewide EIS for Continued Operation of the Los Alamos National Laboratory. DOE is preparing a sitewide EIS for the Los Alamos National Laboratory (LANL) that will provide an analysis of existing and planned activities at that site within the next 5 to 10 years (DOE, 1994e). This EIS is currently in the scoping process, but the EIS is expected to explore environmental impacts caused by LANL facilities and operations, mitigation opportunities for impacts identified, strategies for waste management, and projects reasonably expected over the next 5 to 10 years. Completion of the draft LANL sitewide EIS is anticipated in spring 1996. Wastes expected to be generated from continuing activities at LANL are considered in the WM PEIS, and waste management activities will consider results of the WM PEIS.

Nevada Test Site Environmental Impact Statement. NTS has prepared a sitewide EIS to evaluate the potential impacts that could result from future mission activities (DOE, 1996c). Similar to the INEL Environmental Restoration and Waste Management EIS and the LANL Sitewide EIS, the NTS EIS evaluates both waste management and environmental restoration activities as well as other existing mission activities for the next 10 years. The final NTS EIS was released early in 1996. Waste generation from future activities at NTS was considered and included in the WM PEIS, and waste management activities at NTS will consider decisions arising from the WM PEIS.

Sitewide Environmental Impact Statement for the Rocky Flats Environmental Technology Site. DOE has issued a Notice of Intent (DOE, 1994g) to prepare a sitewide EIS for RFETS. The Notice described the intended scope of the sitewide EIS as providing a basis for selection of a sitewide strategic approach for nuclear materials storage, waste management, cleanup, and economic conversion, as well as project-level decisions for land use, management of nuclear materials, deactivation of RFETS facilities, decontamination and decommissioning of existing facilities, and possible onsite and offsite transportation of radioactive, hazardous, and mixed waste. The scope of the SWEIS has been modified so that issues associated with the safe interim storage of plutonium at RFETS will be analyzed in the Plutonium Interim Storage EIS, and completion of the sitewide EIS has been deferred pending completion of a new RFETS cleanup agreement and decisions based on completion of the WM PEIS.

Plutonium Interim Storage EIS for RFETS. DOE has issued a Notice of Intent (DOE, 1996m) to prepare an EIS for safe interim storage of approximately 10 metric tons of plutonium in inventory at RFETS. The plutonium consists of metals and oxides that were generated during weapons production and oxides generated from stabilization of plutonium-bearing residues. Even though DOE is engaged in a programmatic (Departmentwide) evaluation of alternatives for the long-term storage and disposition of plutonium, no decisions regarding long-term storage and disposition have been made and the Department needs to improve the interim storage arrangements for the plutonium. This EIS will analyze interim storage issues and will serve to ensure that decisions on safe and cost-effective interim storage can be made and implemented in the event that long-term storage and disposition decisions, or the implementation of these decisions, should be delayed for any reason. This EIS will take into consideration any decisions resulting from the completion of the WM PEIS or the *Storage and Disposition of Weapons-Usable Fissile Materials PEIS.*

Environmental Assessment—Solid Residue Treatment, Repackaging, and Storage. The proposed action is to stabilize, if necessary, and repackage approximately 106,600 kilograms of plutonium-contaminated residues (containing approximately 3,100 kilograms of plutonium) for safe interim storage, while awaiting decisions on the further disposition of the materials. Depending on the residue type, stabilization treatment can include oxidation, washing, cementation, calcination, thermal desorption, drying to eliminate liquids, and chemical treatment. Interim storage would be in containers and under conditions appropriate for a period of approximately 20 years, but actual length of storage would be until an appropriate offsite disposal location becomes available. The WM PEIS considers RFETS residues waste for purposes of its programmatic analysis. The subject EA provides greater precision on DOE's plans for managing residues.

Rocky Flats Plutonium Residues and Scrub Alloy EIS. DOE is preparing an EIS that will evaluate the potential environmental impacts associated with reasonable management alternatives for certain plutonium residues and all scrub alloy currently being stored at RFETS in Golden, Colorado (DOE, 1995r). The residues and scrub alloy are materials that were generated during the separation and purification of plutonium or during the manufacture of plutonium-bearing components for nuclear weapons. Preliminary Alternatives are no action, onsite treatment with or without plutonium separation, and offsite treatment with or without plutonium separation. Potential locations for offsite treatment include SRS, LANL, and LLNL.

While SRS appears to be a more likely offsite location for treating the RFETS plutonium residues and scrub alloy due to economies of scale, DOE cannot rule out the possibility that some of these materials might need to be treated at LANL or LLNL. Evaluation of these alternatives at this time will facilitate planning for disposal or other disposition and allow any additional treatment to be integrated with the ongoing stabilization process so that handling the material can be minimized (i.e., by avoiding potential double handling). Minimizing such handling would reduce the worker risk associated with achieving a material form suitable for disposal or other disposition. Any wastes resulting from actions analyzed in the *Rocky Flats Plutonium Residue and Scrub Alloy EIS* would be treated, stored, and disposed of in accordance with the decisions resulting from the WM PEIS.

Savannah River Site Waste Management EIS. The final SRS waste management EIS was issued in July 1995 (DOE, 1995c). It provides a baseline for the analysis of future SRS waste management needs. In the EIS, DOE assessed how to manage over the next 30 years liquid high-level radioactive, low-level radioactive, mixed, hazardous, and transuranic wastes generated during 40 years of past operations and ongoing activities at the Savannah River Site. The wastes are currently stored at SRS. DOE seeks to dispose of the wastes in a cost-effective manner that protects human health and the environment. In the EIS, DOE assessed the cumulative environmental impacts of storing, treating, and disposing of the wastes and examined the impacts on water quality, air quality, ecological systems, land use, geologic resources, cultural resources, socioeconomics, and the health and safety of onsite workers and the public. In the ROD, issued in September 1995, DOE announced its intention to implement the moderate treatment configuration alternative using a phased approach to making decisions on treatment, storage, and disposal facilities identified in the final EIS. The ROD identified decisions regarding continuation of existing activities, current operation of existing facilities, new waste recycling initiatives, operation of the Consolidated Incineration Facility, volume reduction activities for low-level waste, and the operation of a mobile soil sort facility.

Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapons Components EIS. The final EIS issued in December 1996 (DOE, 1996h) evaluates all current and proposed facilities and activities at the Pantex Plant, including weapons dismantlement and storage of the resulting nuclear materials and classified weapons components during the near-term (in a 5- to 10-year period). The sitewide EIS addresses alternative interim storage sites for plutonium pits that result from the Pantex Plant dismantlement activities. Waste generated from activities at the Pantex Plant are considered in the WM PEIS.

Defense Waste Processing Facility Supplemental EIS. DOE issued the final supplemental EIS on completing construction and operation of the Defense Waste Processing Facility (DWPF) in November 1994 (DOE, 1994a). The supplemental EIS assessed the environmental impacts of completing construction and operating the DWPF as modified from the original design addressed in a 1982 EIS. The DWPF includes the HLW pretreatment process, the vitrification facility, saltstone manufacturing and disposal (LLW resulting from the pretreatment of HLW), radioactive glass waste storage facilities, and associated support facilities. The ROD (March 28, 1995) describes the DOE choice to complete construction and start-up testing and begin operation of the DWPF. The ROD also describes additional safety modifications to the DWPF that will substantially reduce or eliminate potential accidental releases of radioactive material and chemicals in the unlikely event of a severe earthquake. When the WM PEIS is completed, DOE will review this supplemental EIS to determine whether a further supplemental or a revised ROD is needed to conform to the HLW canister storage decisions arising from the WM PEIS.

Interim Management of Nuclear Materials at the Savannah River Site (IMNM) EIS. The final EIS was issued in October 1995 (DOE, 1994f, 1995d). In this EIS, DOE assessed the environmental impacts of actions necessary to manage nuclear materials at Savannah River Site until it can make and implement decisions on their ultimate disposition. The actions evaluated in the EIS would stabilize SRS materials that represent environmental, safety, and health vulnerabilities in their current storage conditions or that might represent a vulnerability within the next 10 years. These vulnerabilities are the result of the suspension of nuclear materials production and processing operations that accompanied the end of the Cold War. Although DOE has initiated programmatic and project-specific environmental evaluations on the ultimate disposition of nuclear materials in the DOE complex that are now surplus to national defense requirements, the implementation of decisions on ultimate disposition will take several years, and the decisions themselves are the subject of several ongoing programmatic EISs. In the interim, DOE wants to eliminate vulnerabilities associated with certain current nuclear material nuclear configurations to protect the environment and the health and safety of workers and the public. The first ROD (December 12, 1995) describes the types of materials and methods of processing them in F- and H-Canyon facilities. The second ROD (February 8, 1996) describes fuel elements to be stabilized in F- and H-Canyon facilities and vitrified in the DWPF. The RODs will be reviewed based on decisions resulting from the WM PEIS to determine whether revisions should be made to conform with WM PEIS results.

Tank Waste Remediation System EIS. The Final Tank Waste Remediation System (TWRS) EIS, issued in August 1996 (DOE, 1996q), satisfies the DOE commitment made in the 1988 Hanford Defense Waste

EIS Record of Decision to prepare a supplemental NEPA analysis (DOE, 1994d). The TWRS EIS was prepared in response to several important changes since the 1988 Record of Decision, including a revised strategy to manage and dispose of tank waste and encapsulated cesium and strontium. The approach for achieving environmental compliance at the Hanford Site, including specific milestones for the retrieval, treatment, and disposal of tank waste, is contained in a legally enforceable agreement among DOE, the Washington State Department of Ecology, and EPA, known as the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement).

The TWRS EIS evaluated, as a part of the proposed action: the continued operation and management of the tank farms, including the use of existing and planned facilities such as the Cross-Site Transfer System; waste transfer system upgrades; and the retrieval and treatment of the tank waste, which would include vitrification of HLW and immobilization of the low-activity waste (LAW). The HLW would be stored onsite pending disposal at a geologic repository and the LAW would be disposed of onsite. A range of alternatives was evaluated for the encapsulated cesium and strontium. An ROD is anticipated in October 1996. When the WM PEIS is completed, DOE will review this EIS to determine whether actions stemming from waste generation and disposal conform with decisions arising from the WM PEIS.

Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at Western New York Nuclear Service Center EIS. DOE and the New York State Energy Research Development Authority have prepared a draft EIS (DOE, 1996d) that evaluates alternatives for completing West Valley Demonstration Project (WVDP) activities and managing nuclear waste at the Western New York Nuclear Service Center near West Valley, New York. Radioactive wastes would be produced from vitrifying HLW and from decontaminating and decommissioning tanks, facilities, and hardware associated with the WVDP, and long-term management or closure of the balance of the site. The alternatives being evaluated range from shipping all stored, buried, and newly-generated wastes to other DOE and commercial facilities, to discontinuing operations. The alternatives would be implemented in the 2000 to 2030 time frame. The EIS will take into consideration decisions resulting from the completion of the WM PEIS.

Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel EIS. DOE issued the final Foreign Research Reactor EIS (DOE, 1996e) to adopt a policy to manage SNF from foreign research reactors in a manner consistent with United States nuclear weapons nonproliferation policy. The EIS evaluates the proposed policy which, in part, encourages research reactors to convert from the use of highly enriched uranium (HEU) to low enriched uranium (LEU). The EIS involves the selection of a United States policy on how to manage the spent fuel elements containing United States-origin enriched uranium from 41 nations during a period of up to 13 years. Depending on fuel type, the preferred alternative would be to manage this spent nuclear fuel at the Savannah River Site and the Idaho National Engineering Laboratory. The preferred alternative includes acceptance and management of spent nuclear fuel from the foreign research reactor in the United States. This would include wet or dry storage, processing or chemical separation, if necessary, or a combination of both to stabilize it for either storage or disposal. A review of proposed waste disposal activities in this EIS will be made after considering WM PEIS decisions.

Disposition of Surplus Highly Enriched Uranium EIS. DOE issued the Final Disposition of Surplus Highly Enriched Uranium EIS in June 1996 (DOE, 1996j). This EIS addresses the disposition of a nominal 200 metric tons of surplus HEU (175 metric tons has been declared surplus to defense needs to date) to make the material nonweapons-usable and to recover its economic value where possible. The EIS analyzes a range of alternatives, all of which (other than the "No Action" Alternative) involve blending the HEU down to low-enriched uranium (through isotopic dilution) to make it nonweapons-usable. The EIS analyzes blending the HEU down to an enrichment level suitable for commercial use in nuclear reactors (nominally 4%), or blending it down to an enrichment level suitable for disposal as LLW (nominally 0.9 percent). Four action alternatives are identified that involve blending different portions of the material for commercial use or for disposal as waste, using various combinations of two DOE and two commercial candidate blending sites. All of the commercial use alternatives include the proposal to transfer 50 metric tons of HEU to the United States Enrichment Corporation for blending to LEU and subsequent use in commercial reactor fuel. The ROD based upon the final EIS calls for a blending, over time, of as much of the material as possible (up to 85%) for commercial use, and blending the remainder for disposal as waste. The potential waste loads from the surplus HEU disposition decision are bounded by the inventory projections provided in the WM PEIS.

Hanford Plutonium Finishing Plant Stabilization EIS. DOE issued the *Final Plutonium Finishing Plant Stabilization Draft Environmental Impact Statement* in May 1996 (DOE, 1996i). This EIS evaluates the potential environmental impacts associated with alternative approaches for: (1) stabilization of residual, plutonium-bearing materials at the Plutonium Finishing Plant to a form suitable for long-term storage; (2) removal of readily retrievable, plutonium-bearing material left behind in process equipment, process areas, and air quality and liquid waste management systems as a result of historic uses; and (3) interim storage of stabilized fissile material in existing vaults at the Plutonium Finishing Plant pending the WM PEIS decision on ultimate storage and disposition of the material. The ROD, issued in July 1996, will be reviewed based on decisions made from the WM PEIS.

Waste Isolation Pilot Plant Disposal Phase Supplemental EIS (SEIS-II). WIPP is the planned repository for retrievably stored defense TRUW. In October 1980, DOE issued a final EIS on proposed development of WIPP (DOE, 1980). The January 1981 ROD called for phased development of WIPP, beginning with construction of the WIPP facility. In 1990, DOE issued a supplemental EIS that considered previously unavailable information (DOE, 1990). Based on this supplemental EIS, DOE decided to continue phased development of WIPP by implementing test phase activities. On October 30, 1992, the Waste Isolation Pilot Plant Land Withdrawal Act (WIPP LWA) transferred the WIPP site from the U.S. Department of Interior to DOE. The 1997 Defense Authorization Act, which was signed on September 23, 1996, contains amendments to the WIPP LWA. The amendments make RCRA LDRs inapplicable to WIPP, thus eliminating the need to obtain a No Migration Determination before beginning disposal operations.

DOE has prepared a second supplemental EIS (SEIS-II; DOE, 1996n), which updates the information contained in the previous EIS and Supplemental EIS for WIPP, incorporates the PEIS analysis of various treatment alternatives for TRUW, and examines changes in environmental impacts due to new information or changed circumstances.

The WM PEIS is intended to provide environmental information to assist DOE in determining at which sites it should modify existing TRUW storage and treatment facilities or construct new facilities. DOE intends to select sites for TRUW treatment and storage facilities using the WM PEIS analysis but will not select the level of treatment needed. The WIPP SEIS-II will be used to support decisions on whether to dispose of TRUW at WIPP, the treatment level of TRUW, mode of transportation, and other activities associated with TRUW disposal.

Although the Draft SEIS-II incorporates by reference, and where appropriate, updates and adjusts information from the Draft WM PEIS, the potential actions analyzed in SEIS-II are not connected to the potential actions analyzed in the Draft WM PEIS. The WM PEIS evaluates alternative configurations for managing five types of waste, including TRUW, that are at DOE sites or are otherwise under DOE's control or responsibility. The alternative configurations range from managing the wastes where they are presently located to transporting them to one centralized site for management. The WM PEIS evaluates trends in various impacts under alternative configurations become more or less centralized. The WM PEIS postulates three generic types of treatment for TRUW in order to analyze the impacts of treating and storing TRUW under the various configurations. These generic treatments allow DOE, in the WM PEIS, to compare the relative impacts of centralized, regionalized, and decentralized treatment and storage. To reduce the potential impacts of storing untreated wastes, DOE must decide, pursuant to the WM PEIS, where to treat and store TRUW regardless of whether the Department decides to dispose of this waste at WIPP.

It is important to note that the analysis in the second WIPP SEIS-II will differ from the WM PEIS analysis in several significant aspects. These differences should not be misconstrued as being inconsistent with the WM PEIS, rather the product of different purpose and scope. Again, the impacts of TRUW disposal at the WIPP are not analyzed in the WM PEIS. This information is presented in the WIPP SEIS-II. In addition, the long-term environmental impacts of indefinite storage are also not included in the WM PEIS analysis.

Also, for purposes of bounding the WM PEIS analysis, certain assumptions were made that are inconsistent with current WIPP planning bases and assumptions. For example, although WIPP does not currently have statutory authority to accept nondefense-generated waste, the WM PEIS assumes that all TRUW would be disposed of at WIPP. The WIPP SEIS-II will examine disposal of all TRUW, but only as alternatives to the proposed action that involves disposal of only defense TRUW.

Long-Term Management of Depleted Uranium Hexafluoride EIS. This PEIS will evaluate alternative strategies for long-term management of DOE-owned DUF_6 currently stored at the K-25 site in Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio. The Notice of Intent was published on January 25, 1996 (DOE, 1996s), and the Draft PEIS is scheduled to be available for public review in February 1997. The alternatives are No Action (continued storage until 2020 followed by conversion to uranyl uranate [U_3O_8] and disposition through 2040), long-term storage (beyond 2020) as uranium hexafluoride (UF_6), conversion to an oxide followed by continued storage, conversion to uranium dioxide (UO_2) or metal followed by use, and conversion to an oxide followed by disposal as LLW. The PEIS will consider any decisions resulting from the completion of the WM PEIS.

Medical Isotopes Production EIS. DOE issued the final *Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement* (DOE/EIS-0249F) in April 1996. The EIS identified alternatives and evaluated the potential for significant impacts to the public and the environment of producing molybdenum-99 (Mo-99) domestically. Mo-99 is a precursor of the isotope technetium-99m, which is used approximately 36,000 times each day in the United States for a variety of medical diagnostic purposes. The United States is currently dependent upon a single, aging reactor in Canada for its supply. DOE identified alternative Mo-99 production facilities in four locations: SNL-NM, LANL, ORNL, and INEL. The analysis for each alternative included the identification and description of the waste generated by the Mo-99 process. A combination of facilities at SNL-NM and LANL is identified as the preferred alternative (DOE, 1996f). The ROD, issued in September 1996, will be reviewed based on decisions made in the WM PEIS.

Management of SNF From the K-Basins at the Hanford Site EIS. The final EIS, issued in February 1996 (DOE, 1996g), evaluated whether and how to take action to reduce risks associated with SNF and sludge currently stored in the water-filled K-East and K-West storage basins at the Hanford site. Decisions regarding management of K-Basins SNF were made and implemented in a manner consistent with the Record of Decision for the Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS. Management Alternatives will be reviewed upon completion of the WM PEIS.

Safe Retrieval, Transfer, and Interim Storage of Hanford Tank Wastes. DOE issued the EIS for final safe interim storage of Hanford tank waste (DOE, 1995j) in October 1995. This EIS dealt with urgent tank waste safety concerns that required action before implementing decisions based on the EIS for tank waste remediation system. Alternatives evaluated in the EIS included the construction of new HLW storage tanks and a replacement cross-site transfer line. In the ROD issued in November 1995 (60 FR 61687), DOE decided that existing mitigation measures and tank farm waste inventory management strategies had alleviated the need for additional HLW storage capacity. Therefore, DOE decided not to construct additional double-shell tanks. DOE also decided that the safe interim storage of tank waste did require the construction of a replacement cross-site transfer line between the 200 West Area and 200 East Area of the Hanford site. The transfer line would allow for operational flexibility and permit DOE to continue to stabilize single-shell tank waste in the 200 West Area. These waste management activities will be reviewed pending completion of the WM PEIS.

Hanford Remedial Action EIS and Comprehensive Land Use Plan. The draft Hanford remedial action EIS was published in August 1996 (DOE, 1996p). It establishes future land-use objectives to assist DOE in developing a cost-effective, technically sound remediation strategy for the Columbia River, Central

Plateau, and all other geographic areas of the Hanford Site. The EIS analyzes the impacts of remediating past-practice waste sites that are DOE's responsibility under CERCLA. RCRA past-practice sites that are covered under the provisions of the Hazardous and Solid Waste Amendments of 1984 were also analyzed. In addition, impacts from decontamination and decommissioning of selected surplus facilities were analyzed along with remediation of some miscellaneous RCRA units on or near the primary past-practice remediation sites. The EIS analyzes the impacts of remediation for each future land-use alternative, as well as the cumulative impacts for waste management facilities, such as the Environmental Restoration Disposal Facility.

Savannah River Site F-Canyon Plutonium Solutions EIS. The final F-Canyon Plutonium Solutions EIS was issued in December 1994 (DOE, 1994h). After issuing the Notice of Intent to prepare the EIS on interim management of nuclear materials at SRS, DOE determined that there is a potentially significant safety concern associated with about 85,000 gals of solutions containing plutonium-239. Accordingly, DOE initiated a separate EIS on an urgent schedule for the proposed stabilization of these solutions. The EIS evaluated potential environmental impacts over the next 10 years of alternatives for the stabilization of plutonium solutions stored in F-Canyon. The solutions remain from chemical separations operations that DOE suspended in 1992. The ROD (February 1, 1995) describes the DOE choice to implement the preferred alternative, processing the F-Canyon plutonium solutions to metal, as discussed in the final EIS. Waste management activities described in the EIS will be reviewed based on WM PEIS decisions.

Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories-California. DOE issued a final EIS in August 1992 that evaluates all activities at the Laboratories, including the minimization, treatment, and storage of radioactive and hazardous wastes. The EIS supports decisions on the operation of Laboratory facilities, including specific waste treatment and storage in the near-term (10 years and less), and provides a baseline for analyzing environmental impacts of future waste management activities at the sites (DOE, 1992a). Wastes expected to be generated from LLNL and SNL are included in the WM PEIS analysis. Decisions regarding waste management will be made pending the completion of the WM PEIS.

Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain EIS. The Notice of Intent, published August 1995 (DOE, 1995l), describes Yucca Mountain as the candidate site for disposing of spent nuclear fuel and defense HLW. The Nuclear Waste Policy Act was intended to solve the national problem created by the accumulation of spent nuclear fuel and defense HLW. The Nuclear Waste Policy Act made DOE responsible for managing the disposal of this spent nuclear fuel and HLW, specified the siting process, and authorized the construction of one geologic repository. Under the Nuclear Waste Policy Amendments Act of 1987, the process for selecting this repository was streamlined, and the Yucca Mountain Site in Nevada was selected for detailed study as the candidate site for the nation's first geologic repository. A draft EIS is scheduled for July 1999.

Because the environmental evaluation process for geologic disposal was established by the Nuclear Waste Policy Act, the WM PEIS does not analyze environmental impacts of disposal at Yucca Mountain or alternative locations for a geologic repository. However, the WM PEIS does analyze the environmental impacts of the longer term storage of treated HLW in the event that the construction and operation of a national geologic repository is delayed.

Evaluating Container System for the Management of Naval Spent Nuclear Fuel EIS. *The Department of the Navy Final Environmental Impact Statement for a Container System for the Management of Naval Spent Nuclear Fuel*, issued in November 1996 (Navy, 1996a), evaluates the environmental impacts of alternative container systems for the management of naval SNF following examination at INEL. A container system is needed to place naval SNF in dry storage at INEL and to transport it to a centralized interim storage facility if authorized by Congress or to a geologic repository when one becomes available. The Final EIS specifically addresses the need, alternatives, and environmental impacts of manufacturing containers; loading containers; handling and storage of naval SNF at INEL; transportation of naval SNF loaded containers to a notional repository or centralized interim storage site; and the storage, handling, and transportation of special case waste associated with naval SNF management. The Final EIS demonstrates that the environmental and health impacts are small and comparable among alternatives. The Navy identified a preferred alternative in the Final EIS but will not select an alternative until the Record of Decision is issued. Decisions regarding waste management will be made pending the completion of the WM PEIS.

Disposal of Decommissioned, Defueled Cruiser, OHIO Class, and LOS ANGELES Class Naval Reactor Plants EIS. *The Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Cruiser, OHIO Class, and LOS ANGELES Class Naval Reactor Plants*, issued in April 1996 (Navy, 1996b), analyzes the alternate ways for disposing of decommissioned, defueled reactor compartments from those classes of U.S. Navy vessels. A disposal method for the defueled reactor compartments is needed when the cost of continued operation is not justified by the ships' military capability or when the ships are no longer needed. The preferred alternative is land burial of the entire reactor compartment at the DOE Low Level Waste Burial Grounds at Hanford, Washington. The Record of Decision was published in the *Federal Register* (61 FR 41596) on August 9, 1996, and selects the preferred alternative. The ROD, issued in July 1996, will be reviewed pending completion of the WM PEIS.

S1C Prototype Reactor Plant Disposal EIS. The S1C Prototype reactor plant was permanently shut down in March, 1993, reflecting the end of the Cold War and projected downsizing of the U.S. Naval fleet. All SNF was removed from the S1C Prototype reactor and has been shipped off site. The DOE gave notice of the availability of the Draft EIS in the July 1, 1996, *Federal Register* (61 FR 33908). The Final EIS evaluates in detail three alternatives for the disposal of the S1C Prototype reactor plant (DOE, 1996o). These alternatives include prompt dismantlement and disposal of the entire S1C Prototype reactor plant, deferred dismantlement, and "no action," or continued surveillance and monitoring for an indefinite period of time. The EIS demonstrates that the environmental and health impacts are small and comparable among alternatives. The Navy will select an alternative in the Record of Decision. This EIS will be reviewed based on decisions made in the WM PEIS.

1.8.2 Related DOE Actions and Programs

Environmental Management Accelerating Cleanup: Focus on 2006. The DOE Environmental Management Program is continually working to accelerate cleanup schedules, increase efficiency, and foster cooperative relationships with its regulators and other stakeholders. However, there is concern whether support can be sustained for a program that may stretch beyond 70 years with an estimated cost of more than $200 billion (DOE, 1996l). DOE wants to accelerate reduction of this "cleanup mortgage" of the Cold War to reduce long-term economic and environmental liabilities. DOE is working on a 2006 Plan (previously known as the Ten-Year Plan) to meet this challenge. The vision of this plan is that within the next decade most DOE facilities will be able to treat and dispose of their backlog of nuclear materials and wastes safely and clean up the land and buildings onsite. These steps would dramatically reduce long-term costs and open a large portion of the lands and other resources controlled by DOE for other purposes.

However, some aspects of the Environmental Management Program will demand additional time and resources. For example, DOE will not be able to complete the treatment and disposal of certain wastes such as high-level radioactive waste stored in tanks at Hanford or transuranic waste stored throughout the complex. Also, there will be ongoing groundwater cleanup projects, decontamination of buildings, and surveillance and maintenance activities. At a small number of sites, DOE will continue treatment of a few remaining waste streams.

The 2006 Plan will be used to inform the budget decisions, sequencing of projects, and actions taken to meet program objectives. EM will implement this vision in collaboration with regulators and the public. Development of the 2006 Plan will be guided by the following seven principles:

- Eliminate urgent risks
- Reduce mortgage and support costs to free up funds for further risk reduction
- Protect worker health and safety
- Reduce the generation of waste
- Create a collaborative relationship between DOE and its regulators and stakeholders
- Focus technology development on cost and risk reduction
- Integrate waste treatment and disposal within the complex.

DOE's sites have already prepared initial draft site plans, and DOE is now developing a national discussion draft based upon these principles. The discussion draft will be distributed for public comment to elicit feedback on the strategic approaches for accomplishing compliance and completion goals, and on DOE's management strategies to accomplish these goals. This approach will ensure that DOE has a broad perspective when developing a draft National 2006 Plan later this year. The 2006 Plan will be a living document, evolving to reflect revised assumptions, stakeholder viewpoints, and newly obtained information.

The Final WM PEIS evaluates many potential waste management activities that may become components of the 2006 Plan. To conduct the WM PEIS analysis, DOE assumed that all waste management facilities necessary to implement a given alternative would be constructed in an initial 10-year period, followed by a 10-year operations period. As a result, 20 years of waste generation was analyzed in the WM PEIS. On the other hand, the 2006 Plan will set a goal that waste will be substantially treated and disposed within a 10-year period. Therefore, the WM PEIS considers more waste (existing inventory plus 10 years' new generation) in a period of time similar to the time covered by the 2006 Plan.

Baseline Environmental Management Report. In the Fiscal Year 1994 National Defense Authorization Act, Congress required DOE to submit a report that specified all the activities and projects within the Environmental Management Program. *The 1996 Baseline Environmental Management Report* (BEMR) (DOE, 1996l) includes waste management, transition of operational facilities to safe shutdown status, technology research and development, pollution prevention, and environmental restoration. The report includes an estimate of the total cost of the Environmental Management Program, describes each project or activity at each site, describes the environmental problems, specifies the proposed remedy, and provides a schedule and estimated completion date for each project.

The BEMR was based on a broad range of assumptions regarding the outcomes of various decision-making processes that will determine the ultimate disposition of DOE facilities and sites and thus the scope and pace of the program. One of the key assumptions was related to the location of sites for treatment, storage, and disposal facilities. Current plans and agreements were used to define where waste would be treated and disposed. The WM PEIS examines additional configurations, such as pollution prevention, to that which was used to develop the baseline cost estimate.

Of particular importance to the cost of Environmental Management Programs are the complexwide savings from expanded pollution prevention efforts over the period covered in the BEMR. Results and projections from specific projects demonstrate that the savings from pollution prevention activities could reach tens of billions of dollars, surpassing the initial cost of implementation of these activities. DOE will continue to pursue pollution prevention activities as they relate to the WM PEIS because they result in an efficient use of limited resources by reducing site operating costs, and they maintain consistency with DOE's commitment to respecting the environment.

Environmental Restoration Program. A legacy of the Nuclear Weapons Program is environmental contamination at the sites where research, development, test, and production of nuclear weapons took place. The volumes of contaminated media at some locations are quite large. The Environmental Restoration Program was established to address this problem. "Environmental restoration" refers to activities undertaken pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA) and can include removal and treatment of hazardous substances, containment of a source of contamination, or placement of land use restrictions on a contaminated site. It encompasses a wide range of activities such as stabilizing contaminated soil, treating groundwater, decommissioning process buildings, including nuclear reactors and chemical separations plants, and exhuming buried drums of waste. The extent to which a site is "cleaned up" will depend largely on assumptions regarding future land use. For most sites, the process of determining future site use has just begun.

The CERCLA process is generally implemented at specific sites through agreements among the DOE, EPA, and frequently the host state. The process can be described as follows:

First, a site or portion of a site is "characterized" to identify contaminants, determine the extent of contamination, and assess potential threats to public health and the environment. If significant contamination is indicated, and limited action will result in mitigation of risk, an expedited response action or interim action may be conducted as a means to quickly address the problem. Upon completion of characterization, a detailed analysis is performed to quantify risk and evaluate remedial alternatives. The analysis is followed by a formal decision process including public hearings and formal comment period.

If the results of the analysis indicate that a potential release site is not a threat to health and the environment or that an interim action adequately remediated the contamination, a recommendation of no further action is made to the regulators. If, however, a threat is deemed to be present, the appropriate remediation is identified, and a recommendation is submitted for formal approval. In either case, DOE makes a recommendation on what action is to be taken. The decision on what action will be taken is made by the regulator, not DOE.

During each stage of environmental restoration from characterization of contaminated media to final remediation, waste may be generated. The projected volumes of waste that might be generated by environmental restoration were analyzed by each DOE site during development of the BEMR. These analyses included consideration of treatment, storage, and disposal capabilities, specific restoration requirements, and negotiations with state and Federal regulatory agencies in order to estimate how much of the contaminated media would need to be managed as waste. Estimates and descriptions of total quantities of the contaminated media to be managed, and the wastes that will be generated during environmental restoration are contained in Appendix B. Although most wastes that are generated as a result of DOE's environmental restoration activities would be managed outside of the alternatives evaluated in the WM PEIS, some of the wastes generated by environmental restoration may be transferred to the Waste Management Program. However, given the incomplete information about the final volumes and composition of the transferred wastes, it was not possible to analyze the potential impacts of managing these wastes in the WM PEIS (see Section 1.7.1). The evaluation of waste management facilities in Chapters 6, 7, and 8 does contain information on the anticipated volumes of environmental restoration transferred waste and qualitative analyses of the extent to which these wastes may affect alternatives in the WM PEIS. Appendix B contains a more detailed discussion of ER waste volumes and the potential effects of these wastes on

WM PEIS waste management facilities and alternatives. Decisions based on the WM PEIS are not expected to impact environmental restoration activities at individual sites.

Pollution Prevention Program Plan. The Pollution Prevention Program Plan serves as the principal crosscutting guidance to DOE Headquarters, Operations Office, laboratory, and contractor management to fully implement pollution prevention programs within the DOE complex between now and 2000.

To demonstrate DOE's commitment to pollution prevention, the Secretary of Energy established goals, to be achieved by December 31, 1999, that will reduce DOE's routine generation of radioactive, mixed, and hazardous wastes, and total releases and transfers of toxic chemicals by at least 50%. The Secretary also has established sanitary waste reduction, recycling, and affirmative procurement goals. Site progress in meeting these goals will be reported annually to the Secretary in the *Annual Report on Waste Generation and Waste Minimization Progress*, using 1993 as the baseline year.

Pollution prevention is defined as the use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and wastes into land, water, and air. Pollution prevention includes practices that reduce the use of hazardous materials, energy, water, and other resources along with practices that protect natural resources through conservation or more efficient use.

The Department is faced with the challenge of removing and treating wastes already generated from past production and manufacturing operations. Facility and equipment stabilization, deactivation and decommissioning, and weapons dismantlement activities will also result in significant amounts of wastes that must be handled. Many pollution prevention techniques may not directly apply to wastes that were generated and media that were contaminated by previous practices (nonroutine wastes). However, two techniques, waste segregation and recycling, will be key to reducing the amount of such wastes that would otherwise require additional treatment and disposal.

Additional waste and pollutants will be generated in the process of conducting restoration and dismantlement activities. Pollution prevention is applicable to the generation of secondary wastes and will be incorporated into remedial investigations, feasibility studies, design, and execution of all restoration and dismantlement projects. Restoration projects will be performed in a manner that reduces or prevents the generation of new waste and pollutants and reduces the further release or spread of contamination.

Today, a major barrier impeding the DOE pollution prevention program is the inadequacy of generator involvement in site planning and the shortage of generator project funds to implement pollution prevention opportunities. The DOE pollution prevention program relies on the establishment and maintenance of strong site programs with commitment and support from Headquarters. The success of the overall program hinges on the ability of the sites to reduce pollutant generation and increase recycling rates. Many sites have already achieved positive results from implementing pollution prevention programs. Details on specific pollution prevention programs at the various sites addressed in this PEIS can be obtained from local DOE officials.

In order to provide a conservative analysis of the impacts of DOE's future waste management program, the projected volumes of future waste loads contained in Chapters 6–10 did not assume significant minimization of current waste generation. Appendix G discusses how DOE's pollution prevention program practices may affect waste loads, and consequently the need for facilities. Appendix G contains estimates of reductions in waste loads and associated impacts.

Site Treatment Plans for Mixed Waste Required by the Federal Facility Compliance Act. The FFCAct, which amended RCRA, required DOE to prepare Site Treatment Plans for the development of capacity and technologies for treating mixed waste to RCRA land disposal restriction standards, and to submit them to the State or EPA for approval. A plan is required for each facility at which DOE stores or generates mixed waste.

The FFCAct also subjects Federal facilities to fines and penalties for violations of RCRA. However, DOE was not subject to fines and penalties for violations of the land disposal restrictions for mixed waste until October 6, 1995, and is not subject to fines and penalties after that if it is in compliance with approved plans and compliance orders issued by the appropriate regulator.

DOE followed a three-phased approach for developing the Site Treatment Plans. In October 1993, DOE sites submitted Conceptual Plans to their regulators, which identified a broad range of options for treating DOE's mixed waste. Draft plans, submitted in August 1994, presented the individual sites' proposed treatment option for its mixed waste. Proposed Plans were submitted in April 1995 to the appropriate regulatory agency for approval, approval with modification, or disapproval, as required by the FFCAct.

DOE worked closely with the regulatory agencies and the public throughout the process. The National Governors' Association coordinated representatives from 20 states and EPA to assist DOE in evaluating candidate treatment options and developing mixed waste treatment plans. The conceptual, draft, and proposed plans were also made available to the public, with additional opportunities provided for information and input on the plans at the site and national levels.

Negotiations were completed for 28 plans on October 6, 1995; four additional plans have been finalized since then. Negotiations are ongoing for another three sites; plans for these sites are expected to be finalized in 1997. These plans, taken together, establish a complexwide treatment configuration, including schedules for bringing new treatment facilities into operation. Sixteen of the 17 major sites analyzed in the WM PEIS are required to prepare STPs. Each of these sites has submitted an STP and all but three (ANL-E, BNL, and LLNL) have been approved by the appropriate agencies. Compliance orders or agreements have been made or issued for the approved sites.

The approved plans contain the treatment configuration that resulted from discussions among States, EPA, tribal governments, and the public, and from DOE's evaluation of its treatment needs. However, the evaluation will continue as the plans are implemented to streamline and improve the configuration. For example, individual sites continue to pursue commercial and privatized treatment options for some waste streams. The Compliance Orders that govern implementation of the Plans all provide for modification and changes as new technical and cost information becomes available. Any changes to the configuration or to schedules will be made through formal modification processes.

The Final WM PEIS preferred alternative for LLMW treatment is consistent with the configuration established through the FFCAct process.

DOE Disposal Workgroup Process for Evaluating Potential Mixed Low-Level Waste Disposal Sites. Although the FFCAct does not specifically address disposal of treated mixed wastes, both DOE and the States have recognized that disposal issues are an integral part of treatment discussions. A process was established by the DOE Disposal Workgroup in conjunction with state representatives in the National Governor's Association to evaluate and discuss the issues related to the potential disposal of the residuals from the treatment of DOE LLMW at the sites subject to the FFCAct.

The focus of this process has been to identify sites that are suitable for further evaluation of their potential as disposal sites from the sites that currently store or are expected to generate mixed waste. The evaluation is intended to increase understanding of the strengths and weaknesses of a site's potential for disposal but is not a site selection process. Ultimately the identification of sites that may receive mixed waste for disposal will follow state and Federal regulations for siting and permitting, and will include appropriate public involvement.

Of the DOE sites considered under the process, sites determined to have marginal or no potential for disposal were removed or deferred from further evaluation using the following criteria:

- Grouping of sites in close, geographic proximity
- Screening sites using criteria derived from Federal and state requirements regarding the siting of waste treatment, storage, and disposal facilities
- The application of risk-based criteria related to technical, potential receptor and practical considerations to determine site suitability
- Deprioritization of further evaluation of selected sites with the agreement of states

The remaining sites were evaluated more extensively using site performance evaluations. These 15 sites reflect the same set analyzed for LLMW disposal under the EM PEIS with the exception that the WM PEIS analysis includes Brookhaven. The performance evaluation was used to review site characteristics related to disposal potential and estimate the radionuclide concentration limits of waste that may be disposed at a given site.

Future activities being undertaken by DOE that are either ongoing or are to be completed to facilitate an informed decision about the disposal of DOE LLMW include:

- Develop estimates of waste volumes and radionuclide concentrations in treated residuals
- Compare estimates of radionuclide concentration in treated residuals to performance evaluation-derived radionuclide concentration guides
- Develop sample configurations for disposal of treated residuals
- Develop a draft disposal system configuration

Information obtained through the Disposal Workgroups Process will be considered with information contained in the WM PEIS during the development of an ROD. Following the issuance of the ROD for the WM PEIS, DOE may (1) initiate site-specific NEPA evaluations for new proposed disposal facilities; (2) initiate performance assessment analyses for compliance with DOE Order 5820.2A; and (3) initiate processes for permitting disposal facilities. Coordination with the states and stakeholders will continue to ensure stakeholder input and to resolve concerns at the earliest possible stage.

National Dialogue. DOE recognizes the need to develop an effective decision-making process to integrate not only waste storage, treatment, and disposal decisions, but also other radioactive materials disposition and cleanup decisions as well. In 1995, DOE began an ongoing "national dialogue" on radioactive waste and materials disposition through discussions with interested states, site-specific advisory boards, and other forums. The National dialogue is intended to promote openness, increase trust and confidence in DOE decision making, and complement traditional public outreach efforts conducted under the NEPA process. This effort will allow DOE and stakeholders, especially affected States, to explore decision-making processes that may benefit DOE and host communities. The dialogue will focus on major decisions DOE needs to make over the next few years, principles to be considered in the decision process, and stakeholder involvement. DOE will strive to reach traditional and nontraditional stakeholders in an open and inclusive manner to effectively integrate all potential decision-making processes.

Future Use Project. DOE initiated the Future Use Project in 1994 to begin to evaluate future use options at its sites. The primary purpose of the Future Use Project is to develop stakeholder future use recommendations that can serve as input to efforts and decisions concerning environmental management, site comprehensive planning and stewardship responsibilities, and reuse of excess land and facilities. In light of these goals, the Future Use Project encourages sites to address a number of factors as part of their future use planning processes. In order to develop recommendations that reflect both internal and external preferences, sites should undertake planning processes that include tribal and local governments, regulators, internal program representatives, advisory boards, and advocacy groups, among others. Sites must work with interested individuals and groups to consider data that might influence the development of appropriate recommendations. Relevant information includes existing regulatory agreements, site characteristics, natural resources, cultural and historic resources, contamination profiles, technological feasibility, and cost implications.

Four new areas of focus, in particular, compelled the Department to reconsider and define future uses for its sites with significant involvement by affected governments and the public. As the first new focus, the Department adopted environmental management as a primary mission in response to growing recognition of environmental contamination and the legacy of wastes. Second, the Department has emphasized a new commitment to disclosing information to the public so that the public can make more informed decisions about DOE sites. The Department is also actively involving governmental partners, organizations, and citizens in its decisions. Third, in 1994, the Department issued a secretarial policy on land use that formally recognized its responsibility to act as a steward of national resources. Finally, as defense activities declined and the Environmental Management program matured, the Department recognized the need to define reuse strategies for many of its facilities and buffer areas that are now or will be excess to Departmental mission needs. The overall findings and site recommendations are summarized in *Charting the Course* (DOE, 1996k).

Draft Risk Report. The Draft Risk Report to Congress, entitled *Risks and The Risk Debate: Searching For Common Ground, "The First Step,"* was requested by Congress under the Fiscal Year 1994 House and Senate Conference Committee Report on Energy and Water Development Appropriations. In June 1995, DOE submitted the draft risk report to Congress. The report provides the first link between budget, compliance agreements, and risk. DOE field program managers evaluated the risks associated with all types of environmental management work in a qualitative fashion. The results of that evaluation allowed DOE to capture the spectrum of risks and to link risk to compliance and budget information.

The draft report sets the foundation for a consistent approach in evaluating risks posed by conditions at DOE sites and facilities and in establishing priorities for human health, worker safety, and the environment. In addition to responding to Congress, this report provides public access to risk data, develops recommendations to fill gaps in the available risk information, advances the national debate on the use of risk in decision making, and provides data for establishing priorities among competing requirements.

The Risk Report evaluates the full range of DOE environmental management programs and the activities associated with those programs including waste characterization, treatment, storage, disposal, and minimization; program management; and technology development. Actual or planned activities are evaluated. The Risk Report provides a qualitative summary of the risks and potential risk reduction associated with an activity within six risk categories: public safety and health, worker safety and health, environmental protection, compliance, cost-effective risk management, and site mission completion. However, the focus of the WM PEIS hypothetical programmatic receptor census can be used to support the qualitative risk evaluation provided by the Risk Report.

Nuclear Materials and Facility Stabilization. DOE is responsible for certain nuclear materials that are surplus to the current mission and which may have residual quantities of enriched uranium, plutonium, and other transuranics that may preclude direct disposal of the material at WIPP. These materials are commonly referred to as "residues."

Residues are a byproduct of nuclear weapons material production. Large quantities were generated as a result of the chemical and thermal processes applied to separate and purify plutonium at RFETS, Richland, LANL, LLNL, and SRS. Examples of residue forms include impure oxides and metals, halide salts, combustibles, ash, sludges, and contaminated glass. These materials may also contain RCRA-regulated waste. When nuclear weapons were being produced and the stockpile was growing, the vast majority of these residues were recycled back into the weapons production process. These materials were designed, handled, and packaged for short-term storage. When the weapons production lines were halted in the late 1980s, many materials were left in conditions unsuitable for long-term storage.

Recently, DOE and the Defense Nuclear Facilities Safety Board (DNFSB) initiated activities to investigate the conditions of nuclear materials within the Department. Numerous plutonium packaging and facility vulnerabilities were identified and documented in the DOE *Plutonium Working Group Report* (DOE/EH-0415), *Plutonium Vulnerability Management Plan* (DOE/EM-0199), and DNFSB Recommendation 94-1.

The Department has responded by developing a complexwide implementation plan to address the plutonium vulnerabilities and ensure safe storage of nuclear material until it can be ultimately dispositioned. As part of that plan, some residues throughout the complex will need to undergo some type of treatment process. These processes could include separation of nuclear material, which, if considered weapons-usable, would then become part of the decision-making process associated with the *Storage and Disposition of Weapons-Usable Fissile Material PEIS*. During these processes, secondary TRUW may be generated. Other residues may be designated waste and will need to be treated (along with any secondary wastes) to meet WIPP waste acceptance criteria.

An EIS is currently being developed to address the environmental impacts of alternatives associated with residue processing. Waste volumes for the different alternatives have not been determined but are bounded in both the WM PEIS and the WIPP Supplemental EIS.

Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-2. The DNFSB was established and authorized by Congress to oversee DOE. On September 8, 1994, the DNFSB issued

Recommendation 94-2, "Conformance with Safety Standards at Department of Energy Low-Level Nuclear Waste and Disposal Sites." Recommendation 94-2 concluded that DOE's LLW program has not kept pace with the evolution of commercial practices, that no radiological performance assessments for LLW disposal facilities required by the DOE Order on Radioactive Waste Management had been approved, and that the Department's radiological performance assessments do not account for other source terms that potentially add to the dose projected for LLW disposal facilities. The Board recommended that DOE conduct a complexwide review to establish the dimensions of the LLW problem, take steps to complete the radiological performance assessments, and include in these assessments all interacting source terms. The Board also recommended that DOE issue new standards, requirements and guidance for LLW management and perform a number of studies to improve the management of LLW. To respond to the Board's recommendations, DOE set up tasks in six areas.

- **Systems Engineering for the LLW Program,** which will document LLW system requirements and functions and identify the need for any additional requirements and functions necessary to integrate the program across the complex and accomplish the mission. A study will also be conducted under this task to evaluate the safety merits and demerits of privatizing LLW disposal as one scenario for process improvement.
- **Complexwide Review**, which involved an evaluation of LLW management activities at the 38 DOE facilities that actively manage LLW and LLMW to identify vulnerabilities associated with DOE's management of LLW. Onsite assessments were conducted at the eight DOE sites which manage 80% of the LLW currently being managed. The remaining sites were evaluated through a review of available site information and interviews with DOE headquarters and DOE field and contractor LLW management personnel.
- **DOE Regulatory Structure and Process**, which will provide the policies and requirements needed to improve the management of DOE LLW. Essential requirements for the management of LLW will be identified, developed, and technically justified for functions and activities that are necessary to meet the mission of the LLW Program, and to satisfy the top-level requirements for safety and health of the workers, the public, and protection of the environment. Commercial and international standards will be evaluated and considered for potential adoption by DOE.
- **Radiological Assessments**, which will address the completion and approval of Performance Assessments for LLW disposal facilities and the groundwork for addressing interacting source terms.
- **Low Level Waste Projections**, which will provide a report on current and planned LLW disposal capacity, develop a routine program for projecting waste volumes, and develop a waste minimization strategy.

- **Research and Development**, which will provide the framework to support necessary technology development for LLW.

1.9 DOE Public Reading Rooms

The public reading rooms listed on the following pages are available for referencing documentation related to the WM PEIS. Information regarding the status of this EIS as well as some related EISs can be found at these sites. When a decision regarding the WM PEIS is made, it will be made available to the public at these sites. Information not available at these sites can be accessed through the Office of NEPA Policy and Assistance at 202-586-4600 or the Department of Energy NEPA Information Line at 800-472-2756.

California

DOE Reading Room
1301 Clay Street
Oakland, CA 94612

The State (DTSC) Library
Lincoln Plaza Building
4th and P Street
Sacramento, CA 92410

The State (DTSC) Library
State of California
P.O. Box 806
Sacramento, CA 95812-0806

Lawrence Livermore Eastgate Visitors Center
Greenville Road
Livermore, CA 94550

Simi Valley Public Library
Tapo Canyon Road
Ventura, CA 93001

Davis Public Library
14th Street
Davis, CA 95617

Berkeley Public Library
Kittredge and Shattuck
Berkeley, CA 94794

MINSY Public Affairs
Office Code 1160–Building 47
Vallejo, CA 94592-5100

Concord Branch Library
2900 Salvio Street
Concord, CA 94519

SNL/CA Public Reading Room
7011 East Avenue
Building 901
Livermore, CA 94550

Colorado

Government Reference Center
Mesa County Public Library
530 Grand Avenue
Grand Junction, CO 81503

Technical Resource Center
Grand Junction Project Office
2597 B 3/4 Road
Grand Junction, CO 81503

Rocky Flats Environmental Technology
Site Reading Room
Front Range Community College Library
3645 West 112th Avenue
Westminster, CO 80030

Rocky Flats Citizens Advisory Board
Attn: Ken Korkia
9035 Wadsworth Parkway
Suite 2250
Westminster, CO 80021

U.S. EPA Region VIII
Attn: Michelle Bontrager
999 18th Street, Suite 500
Denver, CO 80202-2405

Colorado Department of Health
Attn: Dan Scheppers
4300 Cherry Creek Drive,
South Denver, CO 80222-2405

Standley Lake Library
Attn: Kathy Hollaran
8485 Kipling Street
Arvada, CO 80005

Connecticut

Windsor Public Library
Attn: Mary Ellen Johnson
323 Broad Street
Windsor, CT 06095

Florida

Jacksonville Public Library
Documents Department
122 North Ocean Street
Jacksonville, FL 32202

Largo Public Library
351 East Bay Drive
Largo, FL 34640

Martin Marietta Specialty Components
Community Relations Center
7381 114th Avenue, North
Suite 403A
Largo, FL 34643

Pinellas Park Public Library
7770 52nd Street, North
Pinellas, FL 34665

Georgia

Atlanta Public Library
Government Documents Section
Attn: Gene Hughs
1 Margaret Mitchell Square
Atlanta, GA 30303

Chatham County Public Library
2002 Bull Street
Savannah, GA 31401

Reese Library
Attn: Elfriede McLean
Document Center
Augusta College
2500 Walton Way
Augusta, GA 30904-2200

Hawaii

Pearl Harbor Naval Base Library
Code 90L
1614 Makalapa Drive
Pearl Harbor, HI 96860-5350

Aiea Public Library
99-143 Monanalua Road
Aiea, HI 96701

Hawaii State Library
478 South King Street
Honolulu, HI 96813

Pearl City Public Library
1138 Waimano Home Road
Pearl City, HI 96782

Idaho

Boise Basin District Library
Attn: Elizabeth Prusha-Parlor
411 Montgomery Street
P.O. Box 219
Idaho City, ID 83631

Boise Public Library
Attn: Julie Davis
Government Documents
715 South Capitol Boulevard
Boise, ID 83702

INEL Oversight Program Library
Department of Health and Welfare
Attn: Nancy Quirk
1410 North Hilton, 3rd Floor
Boise, ID 83706

State Library
Attn: Stephanie Kirkay
325 West State Street
Boise, ID 83702

Library and Archives
State Historical Society
Attn: Wm. E. Tydeman
450 North Fourth Street
Boise, ID 83209

INEL Boise Outreach Office
Attn: Cheryl Burgess
816 W. Bannock, Suite 306
Boise, ID 83702

City of Burley Public Library
Attn: Mona Kenner
1300 Miller Avenue
Burley, ID 83318

Clearwater Memorial Library
Attn: Jill Lynch
402 Michigan Avenue
P.O. Box 471
Orofina, ID 83544

INEL Technical Library
1776 Science Center Drive
P.O. Box 1625
Idaho, ID 83415-2300

Idaho Falls Public Library
Attn: Ginny Atwood
457 Broadway
Idaho Falls, ID 83402

State University Library
Documents Department
Attn: Larry Murdock
P.O. Box 8089
Pocatello, ID 83209

Pocatello Public Library
Attn: Gaila Clough
113 South Garfield
Pocatello, ID 83204

Shoshone-Bannock Library
Attn: Ardith Peyope
Bannock and Pima Streets–HRDC Building
Fort Hall, ID 83203

Twin Falls Public Library
Attn: Linda Parkinson
434 Second Street, East
Twin Falls, ID 83301

Consolidated Free Library
Hayden Branch
Attn: Lee Starr
8385 North Government Way
Hayden Lake, ID 83835

City of Emmett Public Library
Attn: Marsha Werle
275 South Hayes
Emmett, ID 83617

Illinois

Lemont Public Library
Attn: Jackie
810 Porter Street
Lemont, IL 60439

U.S. DOE Public Document Room
Document Department
University Library
3rd Floor Center
University of Illinois at Chicago
801 South Morgan Street
Chicago, IL 60607

Bedford Park Public Library
Attn: Head Librarian
7816 West 65th Place
Bedford Park, IL 60510

Bridgeview Public Library
Attn: Head Librarian
7840 West 79th Street
Bridgeview, IL 60455

Iowa

Ames Laboratory
111 T.A.S.F.
Attn: Steve Karsjen
Ames, IA 50011

Ames Public Library
515 Douglas Avenue
Ames, IA 55001

Kentucky

Environmental Information Center
175 Freedom Boulevard
Kevil, KY 40253

Maine

Rice Public Library
8 Westworth Avenue
Kittery, ME 03904

Missouri

Red Bridge Branch
Mid-Continent Library
11140 Locust Street
Kansas City, MO 64108

U.S. Department of Energy
Attn: Martha Carey
7295 Highway 94 South
St. Charles, MO 63304

Columbia Public Library
Attn: Marilyn McCleod
100 West Broadway
Columbia, MO 65203

Nevada

Carson City Public Library
Attn: Wendell Huffman
900 North Roop Street
Carson City, NV 89701

Nevada State Library
Attn: Patricia Deadder
Capitol Complex
Carson City, NV 89710

Nevada Test Site Reading Room
Coordination and Information Center
Attn: Cinde Ashley
3084 South Highland Drive
Las Vegas, NV 89109

New Hampshire

Portsmouth Public Library
8 Islington Street
Portsmouth, NH 03601

New Jersey

Maywood DOE Public Information Center
43 West Pleasant Avenue
Maywood, NJ 07607

Middlesex County Library
Plainsboro Branch
P.O. Box 278
Plainsboro, NJ 08536

New Mexico

National Atomic Museum
Kirkland Air Force Base
20358 Wyoming Boulevard, South
Albuquerque, NM 87116

Albuquerque Technical Vocational Institute
Main Campus Library
525 Buena Vista Drive, Southeast
Albuquerque, NM 87106

Museum Park Complex
15th and Central
Suite 101
Los Alamos, NM 87544

New York

Longwood Public Library
800 Niddle County Road
Middle Island, NY 11953

Records Center
26 Federal Plaza
29th Floor, Room 2900
New York, NY 10278

EPA Records Center
290 Broadway
New York NY 10007-1866

Mastics-Moriches-Shirley Community Library
425 William Floyd Parkway
Shirley, NY 11967

Brookhaven National Laboratory
Research Library–Building 477A
Upton, NY 11973

Colonie Library
629 Albany-Shaker Road
Loudenville, NY 12211

Saratoga Springs Library
Attn: Claudia Hayes
320 Broadway
Saratoga Springs, NY 12866

Schenectady Public Library
Attn: Tim McGowan
Main Branch
99 Clinton Street
Schenectady, NY 12305-2093

Jennifer Nelson, Public Affairs
MS-Trailer A
10282 Rock Springs Road
West Valley, NY 14171

Buffalo & Erie County Public Library
Science and Technology Department
Lafayette Square
Buffalo, NY 14203

Town of Concord Library
23 North Buffalo Street
Springville, NY 14141

Olean Public Library
Attn: Lance Chaffee
134 North 2nd Street
Olean, NY 14760

North Carolina

Brunswick County Government Center
Attn: Andrea Merklinger
45 Court House Drive, Northeast
Bolivia, NC 28422

New Hanover County Public Library
Attn: Daniel Horn
201 Chestnut Street
Wilmington, NC 28401

Ohio

Columbus Metropolitan Library
Main Branch
96 South Grant Avenue
Columbus, OH 43215

Northside Branch Library
1423 North High Street
Columbus, OH 43201

State Library of Ohio
Attn: Clyde Hordusky
65 South Front Street
Columbus, OH 43215

West Jefferson Public Library
Attn: Sharon Shrum
270 Lily Chapel Road
West Jefferson, OH 43162

Kent State University
Ashtabula Campus Library
3431 West 13th Street
Ashtabula, OH 44004

Public Environmental Information Center
10845 Hamilton Cleves Highway
Harrison, OH 45030

Miamisburg Senior Adult Center
Public Reading Room
305 Central Avenue
Miamisburg, OH 45343

DOE Environmental Information Center
505 West Emmitt Avenue, Suite 3
Waverly, OH 45690

Oregon

Portland State University
Branford Price Millar Library
Attn: Michael Bowman
SW Harrison and Park
Portland, OR 97202

Pennsylvania

Carnegie Library
Attn: James Bobick
Science and Technology Department
4400 Forbes Avenue
Pittsburgh, PA 15213

South Carolina

Charleston County Library
Attn: Nancy Woodward
404 King Street
Charleston, SC 29403

Gregg-Graniteville Library
University of South Carolina-Aiken
Attn: Allison Johnson
171 University Parkway
Aiken, SC 29801

DOE/SRS Public Reading Room
Savannah River Operations Office
Attn: Becky Craft
P.O. Box A
Aiken, SC 29802

South Carolina State Library
Attn: Mary Bostick
1500 Senate Street
Columbia, SC 29201

Tennessee

DOE Environmental Information Resource Center (IRC)
105 Broadway
Oak Ridge, TN 37830

DOE Public Reading Room
Oak Ridge Operations Office
Attn: Amy Rothrock
Room 112B
55 Jefferson Circle
Oak Ridge, TN 37831

Oak Ridge Public Library
Civic Center
1401 Oak Ridge Turnpike
Oak Ridge, TN 37830

Clinton Public Library
Attn: Jane Giles
118 South Hicks Street
Clinton, TN 37716

Lawson McGhee Public Library
Attn: Nelda Hill
500 West Church Avenue
Knoxville, TN 37902

Oliver Springs Public Library
Attn: Jennifer Newcome
607 Easterbrook Avenue
Oliver Springs, TN 37840

Memphis/Shelby County Public Library and Information Center
Attn: Government Publications
1850 Peabody Avenue
Memphis, TN 38104

Rockwood Public Library
Attn: Margaret Marrs
117 North Front Avenue
Rockwood, TN 37854

Texas

Amarillo College Library
Attn: Karen McIntosh
Lynn Library
DOE Reading Room
2201 South Washington
Amarillo, TX 79109

Carson County Library
Public Reading Room
Attn: Teri Keotting
P.O. Box 339
401 Main Street
Panhandle, TX 79060

Mae S. Bruce Public Library
Attn: Rose Holloway
P.O. Box 950
13302 6th Street
Santa Fe, TX 77510

Friendswood Public Library
Attn: Mary Perroni
416 South Friendswood
Friendswood, TX 77546

LaMarque Public Library
Attn: Greg Burns
1011 Bayou Road
La Marque, TX 77568

Genevieve Miller Public Library
Attn: Kathleen Brooks
8005 Barry Street
Hitchcock, TX 77563

Moore Memorial Public Library
Attn: Joanne Turner
1701 9th Avenue North
Texas City, TX 77590

Rosenberg Library
Attn: Jackie Kinsey
2310 Sealley Avenue
Galveston, TX 77550-2296

Helen Hall Public Library
Attn: Shelly Leader
400 West Walker
League City, TX 77537

Houston Public Library
Attn: Carol Johnson
500 McKinney
Houston, TX 77002

Virginia

Portsmouth Public Library
601 Court Street
Portsmouth, VA 23704

Washington

Gonzaga University, Foley Center
Attn: Joyce Cox
East 502 Boone
Spokane, WA 99258

Westinghouse Hanford Company
Environmental Data Management Center
Attn: Debbie Isom
2440 Stevens Center Place
Room 1101
Richland, WA 99352

U.S. Department of Energy Reading Room
Washington State University
Attn: Terri Traub
100 Sprout Road, Room 130
Richland, WA 99352

Department of Ecology
Washington State Nuclear &
Mixed Waste Library
Attn: Marilyn Smith
300 Desmond Drive
Lacey, WA 98503

U.S. Environmental Protection Agency
Attn: Karen Prater
1200 6th Avenue, HW-070
Seattle, WA 98101

University of Washington
Suzzallo Library
Attn: Hillary Reinert
Box 352900
Seattle, WA 98195

Kitsap Regional Library
Attn: Tobey Gustafson
1301 Sylvan Way
Bremerton, WA 98310

Tacoma Public Library
Attn: Larry Mischo
1102 Tacoma Avenue South
Tacoma, WA 98402

Washington, D.C.

U.S. Department of Energy
Room 1E-190
Attn: Carolyn Lawson
1000 Independence Avenue, Southwest
Washington, DC 20585

Center for EM Information
Attn: Kim Tulley
479 L'Enfant Plaza East SW
Suite 7112
Washington, DC 20024

Wyoming

Wyoming State Library
Supreme Court Building
Government Publications
Attn: Venice Beske
Cheyenne, WY 82002

Chapter 1
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CHAPTER 2
Purpose and Need for Action

In accordance with the Council on Environmental Quality (NEPA) regulations, this chapter identifies the Department of Energy's (DOE) proposed action and the purpose and need for DOE action with respect to each of the five waste types analyzed in this Programmatic Environmental Impact Statement (PEIS).

2.1 Proposed Action

DOE is proposing to improve the management (treatment, storage, or disposal) of five types of waste. The Department will comply with all applicable Federal and State laws, to protect public health and safety as well as the environment. In the context of this WM PEIS, management includes:

- Pollution prevention
- Identifying/contracting with private vendors to manage waste
- Modifying existing waste management facilities or constructing new facilities at particular sites
- Operating modified or new waste management facilities at those sites
- Transporting wastes between waste management sites, as necessary
- Handling, surveillance, and maintenance

The WM PEIS will help DOE identify the optimal national configuration for the following waste management activities:

- Treatment and disposal of LLMW
- Treatment and disposal of LLW
- Treatment and storage of TRUW
- Storage of treated (vitrified) HLW canisters until a geologic repository is available
- Treatment of nonwastewater HW

This focus on a national configuration in the first attempt made by DOE to conduct an integrated examination of impacts across the Department's waste management complex and the specific cumulative impacts from all the waste facilities at a given site.

2.2 Purpose and Need for DOE Action

DOE needs to manage its current and anticipated volumes of LLMW, LLW, TRUW, HLW, and HW in order to comply with all applicable Federal and State laws and to protect public health and safety, and to enhance protection of the environment.

DOE is required by the Atomic Energy Act (42 USC 2011 *et seq.*) to manage the radioactive wastes that it generates. LLMW, LLW, TRUW, and HLW have radioactive components. In addition, DOE needs to make waste management decisions concerning HW and hazardous components in mixed wastes (waste that is both hazardous and radioactive) in order to comply fully with the Resource Conservation and Recovery Act (RCRA) (42 USC 6901 *et seq.*). RCRA sets forth requirements for managing HW including mixed waste. HLW, LLMW, and some TRUW are all mixed wastes and thus are subject to RCRA. RCRA requires the U.S. Environmental Protection Agency (EPA) to issue land disposal restrictions (40 CFR 268), which prohibit storage of hazardous and mixed wastes, except to facilitate proper recovery, treatment, and disposal.

The Federal Facility Compliance Act (FFCAct) (42 USC 6961 *et seq.*) amended RCRA to allow EPA and individual States to impose fines and penalties on Federal facilities for RCRA violations. The FFCAct requires DOE to prepare site treatment plans (STPs) for developing treatment capacity for its mixed wastes (waste containing both radioactive and hazardous components subject to RCRA requirements). Sixteen of the 17 major sites analyzed in the WM PEIS are required to prepare STPs. Each of these sites has submitted an STP, and all but three (ANL-E, BNL, and LLNL) have been approved by the appropriate agency. Compliance orders or agreements have been issued or made for the approved STPs. The FFCAct subjects DOE to fines after October 6, 1995, for violations of RCRA's LDRs for waste storage, unless the site is otherwise in compliance with an approved STP and compliance order issued by the appropriate waste regulator. The WM PEIS provides the NEPA basis for the FFCAct LLMW treatment configuration, while the FFCAct STPs detail the LLMW treatment program.

DOE manages each waste type separately and therefore will make waste management decisions by waste type.

2.2.1 Low-Level Mixed Waste

This PEIS examines the potential environmental impacts of treatment and disposal of LLMW. Although existing commercial and DOE capacity is insufficient to treat DOE's LLMW it is possible that some portion of the inventory could be treated at commercial facilities and that overall capacity could increase to meet demand. To comply with the land disposal restrictions and the FFCAct, DOE has developed site-specific plans for developing treatment capacities for the LLMW stored, generated, and disposed of at its sites. Although the FFCAct does not require DOE to develop plans for LLMW disposal, DOE also needs to determine where to dispose of treated LLMW.

2.2.2 Low-Level Waste

This PEIS examines the potential environmental impacts of treatment and disposal of LLW. Currently, LLW is packaged to meet waste acceptance criteria where it is generated and is disposed of at six DOE sites. This arrangement for disposing of LLW at a limited number of sites has evolved based on past research and weapons production operations, without considering either the total quantities of LLW generated or the sites at which it is generated. Accordingly, DOE needs to re-examine its management of LLW and determine where to dispose of LLW in the future. As part of this decision, DOE also needs to consider where LLW should be treated before disposal.

2.2.3 Transuranic Waste

This PEIS examines the potential environmental impacts of treatment and storage of TRUW. Since 1970, DOE has stored all of its TRUW, including TRUW containing hazardous components that are subject to RCRA. DOE is proposing to dispose of its retrievably stored defense TRUW in a geologic repository known as the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, if acceptable disposal performance can be demonstrated and regulatory requirements are met. Several studies are under way to characterize and understand more fully the potential long-term behavior of the disposal of TRUW at WIPP. Based on the results of these studies and independent of this PEIS, DOE will determine whether to dispose of TRUW at WIPP. To reduce the potential for delays in future TRUW disposal at WIPP, DOE needs to identify those sites where TRUW would be treated and stored.

2.2.4 HIGH-LEVEL WASTE

This PEIS examines the potential environmental storage impacts of treated (vitrified) HLW canisters. DOE is proceeding with plans at four sites to treat HLW by processing it into a glass form that would not be readily dispersible into the air or leachable into ground or surface water. Under the Nuclear Waste Policy Act (42 USC 10101–10270), treated HLW is to be disposed of in a geologic repository. Because of delays in opening this repository (now scheduled to open in 2010, with acceptance of DOE-managed HLW beginning in 2015), the quantity of treated HLW requiring storage will be more than originally anticipated, and the post-treatment storage time will also be greater. Thus, DOE needs to decide whether storage facilities for treated HLW should be constructed at the four HLW sites or whether larger storage facilities should be built at fewer sites. Treated HLW would be stored at these facilities until a geologic repository becomes available for permanent disposal.

2.2.5 HAZARDOUS WASTE

This PEIS examines the potential environmental impacts of treatment of nonwastewater HW. Currently, DOE uses a combination of its own and commercial treatment, storage, and disposal facilities for HW, as determined by each site that generates this material. DOE treats about 99% of its HW (primarily wastewater) onsite, and ships about 1% (primarily organic substances such as solvents and cleaning agents) to commercial HW facilities. DOE needs to decide the extent to which it should rely on commercial facilities for the treatment of nonwastewater HW.

CHAPTER 3
Alternatives

This chapter describes the four categories of waste management alternatives analyzed in the Waste Management Programmatic Environmental Impact Statement (WM PEIS). It also describes the methodology used to develop the alternatives and the alternatives considered but not analyzed in detail. A comparison of the impacts of the alternatives can be found in the waste-type Chapters 6 through 10.

3.1 Introduction

This chapter describes the waste management alternatives considered in the WM PEIS. These alternatives reflect different national configurations of particular sites evaluated in this document for the management of low-level mixed waste (LLMW), low-level waste (LLW), transuranic waste (TRUW), high-level waste (HLW), and hazardous waste (HW). The alternatives considered for each waste type fall within four broad categories: the No Action Alternative and the Decentralized, Regionalized, and Centralized Alternatives. Under each of the four broad categories for each of the five waste types, there are one or more alternatives that vary by the number and location of U.S. Department of Energy (DOE) sites at which waste management facilities could be located.[1] As shown in Table 3.1–1, 36 alternatives from the four categories are evaluated for the five waste types. The waste management alternatives eventually selected by DOE may vary among the five waste types. The configurations considered for each waste type, including the name of each site included in a particular configuration, are presented in Section 3.4.

3.2 Regulatory Background

The Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA) (42 USC 4231 *et seq.*) require Federal agencies to include a discussion of all reasonable alternatives to the proposed action in an environmental impact statement (EIS) (40 CFR 1502.14). An agency must provide sufficient information for each alternative so that reviewers may evaluate the comparative merits of those alternatives.

[1] The alternatives within the four broad categories of alternatives are sometimes referred to as "cases" in the accompanying appendices and technical reports.

Table 3.1-1. Number of Alternatives Analyzed by Waste Type

Category	LLMW	LLW	TRUW	HLW*	HW	TOTAL
No Action	1	1	1	1	1	5
Decentralized	1	1	1	1	1	5
Regionalized	4	7	3	2	2	18
Centralized	1	5	1	1	0	8
TOTAL	7	14	6	5	4	36

* HLW alternatives are analyzed both in terms of final disposal beginning in 2015 and final disposal beginning at some later date. However, the decision of when disposal will begin is not part of the WM PEIS. A separate National Environmental Policy Act (NEPA) document will be prepared in accordance with the HLW candidate program.

In addition, an EIS must include a discussion of the "No Action Alternative." Such a "status quo" alternative would not necessarily comply with applicable laws and regulations, but it provides an environmental baseline against which the impacts of other alternatives can be compared.

For alternatives that were eliminated from detailed study, the agency must briefly discuss the reasons for their elimination. Further, the agency must identify its preferred alternative or alternatives, if one exists, in the draft EIS, and must identify the preferred alternative in the final EIS unless another law prohibits the expression of such a preference.

3.3 Four Categories of Alternatives

In this PEIS, an alternative is the configuration of sites for treating, storing, or disposing of a specific waste type. The categories of alternatives analyzed in this PEIS for each waste type are No Action, Decentralized, Regionalized, and Centralized. These categories are described below:

No Action Alternative. Selection of this alternative would involve using only currently existing or planned waste management facilities at DOE sites or commercial vendors.

Decentralized Alternatives. Selection of these alternatives would result in managing waste where it is or where it will be generated, treated, or disposed of in the future. Unlike the No Action Alternative, the

Decentralized Alternatives may require the siting, construction, and operation of new facilities or the modification of existing facilities. Under the Decentralized Alternatives, the waste management facilities would be located at a larger number of sites than under the Regionalized or Centralized Alternatives.

Regionalized Alternatives. Selection of these alternatives would result in transporting wastes to various numbers of sites (fewer than the number of sites considered for the Decentralized Alternatives but greater than the number of sites considered for the Centralized Alternatives). In general, those sites that now have the largest volumes of a given waste type were considered as regional sites for treatment, storage, or disposal.

Centralized Alternatives. Selection of these alternatives would result in transporting wastes to one or two sites for treatment, storage, or disposal. As with the Regionalized Alternatives, those sites that have the largest volumes of a given waste type were considered as sites for Centralized treatment, storage, or disposal.

3.4 Alternatives Under Each Category

An alternative is the configuration of sites for treating, storing, or disposing of a specific waste type. For example, under "LLMW Regionalized Alternative 2," DOE would transport LLMW to seven sites for treatment and treated LLMW to six sites for disposal. Each alternative specifies the sites involved. The alternatives considered under each category for each waste type are described fully in the subsequent waste-type Chapters 6 through 10. The following tables (3.4–1 through 3.4–5) identify, by alternative for each site, the proposed waste management actions at that site.

The alternatives were developed and defined to incorporate all possible actions of DOE concerning waste management. They were based on waste type origin and character, current and projected volumes and locations within the DOE complex, existing facilities and capabilities, and specialized treatment and disposal requirements. The analysis of the alternatives presented in this PEIS encompass the human health risks; environmental, transportation, and socioeconomic impacts; and costs associated with the range of waste treatment, storage, and disposal activities available to DOE.

Table 3.4-1. Proposed Waste Management Actions at Each Site Under the Low-Level Mixed Waste Alternatives[a]

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	CH Nonalpha Treat	Dispose																
No Action	3	0	S	S	S	S	TS	S	S	S	TS	S	S	S	S	S	TS	S
Decentralized	37	16	TD	TD	TD	TD	TD$\propto$[b]	TD$\propto$	TD$\propto$	TD$\propto$	TD	TD	TD	TD	TD$\propto$	TD	TD$\propto$	TD
Regionalized 1	11	12			TD	TD	TD$\propto$	TD$\propto$	TD$\propto$	D$\propto$	TD	TD	TD	TD	TD$\propto$		TD$\propto$	
Regionalized 2	7	6				TD	TD$\propto$	TD$\propto$		D$\propto$	TD			T	T$\propto$		TD$\propto$	
Regionalized 3	7	1				T	T$\propto$	T		D$\propto$	T			T	T$\propto$		T$\propto$	
Regionalized 4	4	6				TD	TD$\propto$	D$\propto$		D$\propto$	TD						TD$\propto$	
Centralized	1	1				TD$\propto$												

Notes: T = treatment to meet land disposal restrictions; D = disposal; S = indefinite storage. All sites have wastewater treatment capability as needed. Treatment, storage and disposal could also take place at a privatized or commercial facility on a site- or project-specific basis. Blanks indicate that treatment, storage, or disposal of LLMW does not occur at a site under the specified alternative.

[a] The actions shown are for contact-handled (CH) wastes. Contact-handled waste is subdivided into two types of LLMW, alpha and nonalpha. These two types of LLMW are generally treated in separate facilities. Remote-handled (RH) wastes would be treated and disposed onsite at the Hanford Site, INEL, ORR, and SRS in all alternatives except No Action. RH waste would be stored under No Action.

[b] Facilities with the $\propto$ symbol treat or dispose of both contact-handled alpha and nonalpha waste.

Table 3.4-2. Proposed Waste Management Actions at Each Site Under the Low-Level Waste Alternatives

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	Treat	Dispose																
No Action	10[a]	6				TD	TD	D	T	D	TD	T			T		TD	
Decentralized		16	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Regionalized 1		12			D	D	D	D	D	D	D	D	D	D	D		D	
Regionalized 2	11	12			TD	TD	TD	TD	TD	D	TD	TD	TD	TD	TD		TD	
Regionalized 3		6				D	D	D		D	D						D	
Regionalized 4	7	6				TD	TD	TD		D	TD			T	T		TD	
Regionalized 5	4	6				TD	TD	D		D	TD						TD	
Regionalized 6		2				D											D	
Regionalized 7		2								D							D	
Centralized 1		1				D												
Centralized 2		1								D								
Centralized 3	7	1				TD	T	T			T			T	T		T	
Centralized 4	7	1				T	T	T		D	T			T	T		T	
Centralized 5	1	1				TD												

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. All sites would do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. Treatment, storage, and disposal could also take place at a privatized or commercial facility on a site- or project-specific basis. Blanks indicate that LLW is not treated or disposed at a site under the specified alternative.
D=dispose. Each of the 6-site disposal alternatives uses the 6 same sites; each of the 12-site disposal alternatives uses the same 12 sites.
[a] Ten sites use existing facilities for volume reduction. Three sites (LBL, RMI, and Mound) not listed as major sites above include volume reduction facilities.

Table 3.4–3. Proposed Waste Management Actions at Each Site Under the Transuranic Waste Alternatives

Alternative	Number of Sites CH Treat	Number of Sites RH Treat	Treat Stand	ANL–E	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	RFETS	SNL–NM	SRS	WIPP	WVDP
No Action	11	5	WIPP-WAC	TS	TS	TS	TS	TS	S	TS	S	TS	S	TS		S
Decentralized	16	5	WIPP-WAC	TS	TS	TS	TS	TS	TS	TS	T	TS	T	TS		T
Regionalized 1	5	2	Reduced gas		TS[a]	TS	TS			TS[b]		TS		TS		
Regionalized 2	5	2	LDR		TS[a]	TS	TS			TS[b]		TS		TS		
Regionalized 3	3	2	LDR		TS[a]	TS				TS[b]				TS		
Centralized	WIPP	2	LDR		TS[c]					TS[b]					T	

Notes: T = treatment to one of three standards: process to current waste acceptance criteria at WIPP (WIPP-WAC); shred and grout to reduce potential for gas generation at the repository (Reduced Gas); and treat to meet land disposal restrictions using thermal organic destruction and complete treatment train; S = storage after treatment under No Action and Decentralized Alternatives or store current inventory under the No Action Alternative. Blanks indicate that TRUW is not treated or stored at a site under the specified alternative.

[a] The Hanford Site treats both contact-handled (CH) and remote-handled (RH) waste.

[b] ORR treats RH waste only.

[c] The Hanford Site treats RH waste only.

Table 3.4–4. Proposed Waste Management Actions at Each Site Under the High-Level Waste Alternatives

Alternative	Store	Hanford	INEL	SRS	WVDP
No Action	4	S	S	S	S
Decentralized	4	S	S	S	S
Regionalized 1	3	S	S	S	
Regionalized 2	3	S	S	S	
Centralized 1[a]	1	S			

Note: S = storage. Blanks indicate that LLW is not stored at INEL, SRS, and WVDP under the specified alternative.
[a] Canisters generated at WVDP, SRS, and INEL prior to acceptance at the candidate repository in 2015 would be shipped to the Hanford Site for storage. Canisters generated at SRS and INEL after 2015 would be shipped directly to the candidate repository. If acceptance of the DOE-managed HLW is delayed past 2015, then all HLW canisters would be shipped to the Hanford Site for storage.

Table 3.4–5. Hazardous Waste Alternatives

Alternative	Treat	ANL–E	Hanford	INEL	LANL	LLNL	ORR	Pantex	SNL–NM	SRS
No Action	2			T			T			
Decentralized	3			T			T			T
Regionalized 1	5		T	T	T		T			T
Regionalized 2	2			T			T			

Note: T = treatment. Blanks indicate that HW is not treated at a site under the specified alternative. Fermi and KCP were not included in this table because they are not major sites as defined in Section 1.6 of Volume I, and impacts were not evaluated at those sites.

Although the four broad categories of alternatives analyzed for each waste type encompass the range of reasonable alternatives available to DOE, there are many possible combinations for the number and locations of DOE sites for treatment, storage, and disposal facilities. To narrow these combinations to a level where meaningful analysis could occur, DOE selected a range of reasonable alternatives for analysis under each category.

The waste management configuration that DOE ultimately selects for a particular waste type is not necessarily limited to one of the alternatives presented. A hybrid alternative could be developed that would incorporate components from one or more of the alternatives analyzed. For example, DOE may choose to treat a particular waste type on a regionalized basis and dispose of it at a centralized location. Another example would be to select a disposal site analyzed under a centralized alternative and additionally select a second disposal site analyzed under a regionalized alternative.

3.5 Methodology for Selecting and Identifying Alternatives

The PEIS considers alternatives within the four broad categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. However, the number of possible alternatives under these broad categories is vast. For example, LLMW is generated, stored, or projected to be generated at 16 major sites. From one to 16 sites could be possible alternatives for the treatment of LLMW, and from one to 16 sites could be possible alternatives for disposal. The same general multisite scenario holds true for the other waste types.

The three "action" categories of alternatives encompass the range of reasonable alternatives available to DOE for the siting of waste management facilities. The Decentralized Alternatives consider waste management facilities at major sites where the waste is located or could be generated in the future, the Centralized Alternatives consider waste management facilities at one or two major sites, and the Regionalized Alternatives consider waste management activities at a number of major sites in between all and one. More than one Regionalized Alternative is considered for all waste types.

In order to determine reasonable proposed sites for Regionalized or Centralized waste management facilities, DOE determined where the largest waste volumes are located and where transportation requirements would be minimized. Treatment, storage, or disposal facilities were analyzed at those sites. However, total volumes of waste were not the sole criterion used to select Regionalized or Centralized sites. The character of the waste, specialized treatment requirements, and existing facilities were also taken into account. For example, some wastes that require special treatment were analyzed separately, and treatment sites were selected for analysis based on the volumes requiring special treatment rather than on total volumes.

3.6 Alternatives for Specific Waste Types

Complete descriptions of the alternatives, an analysis of the environmental impacts, and a comparison of the impacts are contained in the subsequent waste-type Chapters 6 through 10. Alternatives considered under each category in the WM PEIS are summarized in the following tables (3.6–1 through 3.6–5) for each waste type.

Table 3.6-1. Low-Level Mixed Waste—7 Alternatives

No Action	Sites would use existing and approved treatment facilities; residues from treatment would be stored indefinitely; LLMW would not be transported
Decentralized	All sites with contact-handled wastes would treat, and 16 sites would dispose of contact-handled wastes (remote-handled waste is treated and disposed of at 4 sites)
Regionalized (4 Alternatives)	1 Treatment of contact-handled wastes would occur at 11 sites; disposal would occur at 12 sites 2 Treatment of contact-handled wastes would occur at 7 sites; disposal would occur at 6 sites 3 Treatment of contact-handled wastes would occur at 7 sites; disposal would occur at 1 site 4 Treatment of contact-handled wastes would occur at 4 sites; disposal would occur at 6 sites
Centralized	The Hanford Site would treat and dispose of LLMW (remote-handled wastes would be treated and disposed of at 4 sites)

Table 3.6-2. Low-Level Waste—14 Alternatives

No Action	All sites would transport and dispose of LLW at 6 sites (the Hanford Site, INEL, LANL, NTS, ORR, SRS) under current arrangements; all sites would use existing treatment facilities
Decentralized	16 sites would dispose of all LLW projected to be generated over the next 20 years; a minimum level of treatment at each site is assumed
Regionalized (7 Alternatives)	2, 6, or 12 sites would dispose of all LLW projected over the next 20 years; in three alternatives, treatment to reduce volumes is also assumed, using regional sites 1 Disposal of LLW at 12 sites, without volume reduction 2 Volume reduction at 11 sites; disposal at 12 sites 3 Disposal at 6 sites, without volume reduction 4 Volume reduction at 7 sites; disposal at 6 sites 5 Volume reduction at 4 sites; disposal at 6 sites 6 Disposal at 2 sites (the Hanford Site and SRS), without volume reduction 7 Disposal at 2 sites (NTS and SRS), without volume reduction
Centralized (5 Alternatives)	One site (either the Hanford Site or NTS) disposes of all LLW projected over the next 20 years; in three alternatives, treatment to reduce volumes is also assumed 1 Disposal at the Hanford Site, without volume reduction 2 Disposal at NTS, without volume reduction 3 Volume reduction at 7 sites; disposal at the Hanford Site 4 Volume reduction at 7 sites; disposal at NTS 5 Volume reduction and disposal at the Hanford Site

Table 3.6-3. Transuranic Waste—6 Alternatives

No Action	Continue storage in existing facilities
Decentralized	TRUW would be treated to meet WIPP current criteria. Sites with small amounts would transport to 10 largest sites until disposal at WIPP
Regionalized (3 Alternatives)	1 Contact-handled TRUW would be treated at 5 sites and remote-handled TRUW would be treated at 2 sites, to intermediate level (to reduce gas generation), and transported to WIPP for disposal 2 Same as Regionalized 1, but waste would be treated to more stringent levels to meet land disposal restrictions (LDRs) 3 Contact-handled TRUW would be treated at 3 sites, and remote-handled TRUW at 2 sites to meet LDRs, then transported to WIPP for disposal
Centralized	Contact-handled TRUW would be transported to WIPP for treatment to meet LDRs and disposal; remote-handled TRUW would be transported to ORR and the Hanford Site for treatment to LDRs and then to WIPP for disposal

Table 3.6-4. High-Level Waste—5 Alternatives

No Action	HLW canisters would be stored at the Hanford Site, SRS, and WVDP until acceptance at geologic repository; HLW at INEL would be stored as calcine or liquids
Decentralized	HLW canisters of solidified waste would be stored at the 4 sites producing canisters until acceptance at geologic repository
Regionalized (2 Alternatives)	1 Canisters from WVDP would be transported to SRS; canisters would be stored at the Hanford Site, SRS, and INEL until acceptance at geologic repository 2 Canisters from WVDP would be transported to the Hanford Site; canisters would be stored at the Hanford Site, SRS, and INEL until acceptance at geologic repository
Centralized	Canisters would be transported from WVDP, INEL, and SRS to the Hanford Site; canisters would be stored at the Hanford Site until acceptance at geologic repository

Note: Each of the five alternatives is analyzed under two timing assumptions: (1) acceptance at the candidate repository begins in 2015; and (2) acceptance is delayed past 2015.

Table 3.6-5. Hazardous Waste—4 Alternatives

No Action	Nonwastewater HW would continue to be transported to commercial facilities; two DOE sites would thermally treat organic materials
Decentralized	Similar to the No Action Alternative, except organic materials would be thermally treated at three DOE sites
Regionalized (2 Alternatives)	1 50% of nonwastewater HW would be treated at five DOE sites (the Hanford Site, INEL, LANL, ORR, and SRS); 50% would be treated at commercial facilities 2 90% of nonwastewater HW would be treated at two DOE sites (INEL and ORR); 10% would be treated at commercial facilities
Centralized	None

3.7 Preferred Alternatives

The DOE selected its preferred alternatives after considering the analyses presented in the WM PEIS, the decision criteria presented in Section 1.7 of Volume I, and all of the comments submitted on the Draft WM PEIS. Table 3.7-1 summarizes the preferred alternatives for all of the major sites analyzed in the WM PEIS, and Tables 3.7-2 through 3.7-6 identify the waste management activities that each of the major sites would conduct under the preferred alternative. The preferred alternatives for each waste type are as follows.

Treatment of LLMW. A number of the Department's sites (generally sites with small amounts of LLMW) would send their LLMW to other sites for treatment. The sites that would receive these wastes and treat them under the DOE's preferred alternative are Hanford, INEL, ORR, and SRS. ANL-E, FEMP, LLNL, LANL, Pantex, PORTS, RFETS, and SNL-NM would treat LLMW onsite.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several Regionalized Alternatives as shown in Table 3.7-1. The potential environmental impacts of all alternatives for treatment of LLMW evaluated in the WM PEIS are small. DOE's preferred alternative is generally consistent with the Site Treatment Plans prepared under the FFCAct; these plans include the use of commercial facilities to treat some LLMW. DOE realizes that the compliance orders issued by State and Federal regulators on the basis of these Site Treatment Plans establish the requirements for treatment of DOE's LLMW.

Table 3.7-1. Summary of Preferred Alternatives

Waste Type	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR
LLMW	Treatment	D	R1[a]	D	R1	R4	D	D	R1[a]	R2
	Disposal[b]	R	R	R	R	R	R	R	R	R
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	R3	R3
	Disposal[b]	R	R	R	R	R	R	R	R	R
TRUW	Treatment	D			D	R3	D	D	D	R1
HLW	Storage				D	D				
HW	Treatment	N	-	-	N	N	N	N	-	N

Waste Type	Decision	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	WIPP
LLMW	Treatment	R2	D	D	D	D	R1	R1[a]	
	Disposal[b]	R	R	R	R	R	R	R	
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	
	Disposal[b]	R	R	R	R	R	R	R	
TRUW	Treatment	D	**		D	R1	R1	D	*
HLW	Storage						D	D	
HW	Treatment	-	N	-	-	N	N	-	

Notes: N = No Action; D = Decentralized; R1, R2, R3, R4 = Regionalized; - = site not analyzed as a major generating site; * = no impacts from treatment or storage. ** = the very small amount of TRUW at Pantex would be shipped to LANL for treatment and storage. A blank cell indicates that the waste type is not found at the site.

[a] Wastes from these sites (BNL, NTS, and WVDP) are shipped offsite to regional treatment centers.

[b] DOE prefers to further narrow its configuration of LLMW and LLW disposal sites to two to three sites. The selection of sites would be made following consultation with regulatory authorities, State and Tribal governments, and other interested stakeholders.

Table 3.7–2. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLMW

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
Ames	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
ANL-E	Treatment	Onsite		Some waste may be shipped to regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
BCL	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Bettis	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
BNL	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Charleston	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
ETEC	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
FEMP	Treatment	Onsite[d]		Some waste may be shipped to regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
GA	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
GJPO	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
Hanford	Treatment	Onsite	Regional treatment site[b]	
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
INEL	Treatment	Onsite	Regional treatment site[b]	Some INEL waste may be shipped to another regional treatment site[b]
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
KCP	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
KAPL	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LEHR	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LBL	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LLNL	Treatment	Onsite		Some waste may be shipped to regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
LANL	Treatment	Onsite		
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
Mare Island	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]

Table 3.7-2. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLMW—Continued

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
Mound	Treatment	Onsite[e]		Regional treatment site[b,e]
	Disposal	Offsite		Regional disposal site[c]
NTS	Treatment	Offsite		Regional treatment site[b]
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
Norfolk	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
ORR	Treatment	Onsite	Regional treatment site[b]	
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
PGDP	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Pantex	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
Pearl Harbor	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Pinellas	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
PORTS	Treatment	Onsite[f]		Regional treatment site[b,f]
	Disposal	Offsite		Regional disposal site[c]
Ports Nav	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
PPPL	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
Puget So	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
RMI	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
RFETS	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
SNL-NM	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[c]
SRS	Treatment	Onsite	Regional treatment site[b]	Some SRS waste may be shipped to another regional treatment site
	Disposal	Onsite/offsite	Potential regional disposal site	Regional disposal site[c]
UofMO	Treatment	Offsite		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]
WVDP	Treatment	Offsite[d]		Regional treatment site[b]
	Disposal	Offsite		Regional disposal site[c]

See footnotes on next page.

Table 3.7–2. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLMW—Continued

Note: A blank cell indicates that a site either does not receive LLMW from other sites or does not ship LLMW to other sites.
[a] A site is listed if it currently manages LLMW or is expected to manage it in the future.
[b] The regional treatment sites would be Hanford, INEL, ORR, or SRS, depending upon which site is shipping waste. The configuration analyzed in the WM PEIS for Hanford, INEL, ORR, and SRS is not exactly the same as those in the Site Treatment Plans; under the Site Treatment Plans:

- Hanford receives LLMW from BCL;
- INEL receives LLMW from Bettis, Charleston, ETEC, KAPL, LBL, LLNL, Mare Island, NTS, Norfolk, Pearl Harbor, PORTS, Puget So, SRS, and UofMO;
- ORR receives LLMW from ANL-E, BNL, FEMP, INEL, LBL, Mound, NTS, PGDP, PORTS, RMI, and WVDP; and
- SRS receives LLMW from Bettis, Charleston, KAPL, and Norfolk.

The evaluation of impacts at each of the major sites under the Preferred Alternative provides similar results as the configurations specified in the Site Treatment Plans. DOE realizes that the Site Treatment Plans, unless modified by the appropriate regulatory agency, establish the requirements for treatment of DOE's LLMW.
[c] The selection of two or three regional disposal sites will be made following further consultation with regulatory agencies, State and Tribal Governments, and other interested stakeholders.
[d] Site Treatment Plan indicates some waste may be treated onsite.
[e] Site Treatment Plan indicates some waste may be treated offsite at ORR.
[f] Site Treatment Plan indicates some waste may be treated offsite at INEL and ORR.

Table 3.7–3. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLW

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
Ames	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
ANL-E	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Bettis	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
BNL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Fermi	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
FEMP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Hanford	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
INEL	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
KCP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
KAPL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
LBL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]

Table 3.7–3. Waste Management Activities Under the Preferred Alternative for Treatment and Disposal of LLW—Continued

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to
LLNL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
LANL	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
Mound	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
NTS	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
ORR	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
PGDP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Pantex	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
Pinellas	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
PORTS	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
PPPL	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
RFETS	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
RMI	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
SNL-NM	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
SRS	Treatment	Onsite		
	Disposal	Onsite or offsite	Potential regional disposal site	Regional disposal site[b]
SLAC	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]
WVDP	Treatment	Onsite		
	Disposal	Offsite		Regional disposal site[b]

Note: A blank cell indicates that a site *either* does not receive LLW from other sites or does not ship LLW to other sites.
[a] A site is listed if it currently manages LLW or is expected to manage it in the future.
[b] The selection of two or three regional disposal sites will be made following further consultation with regulatory agencies, State and Tribal governments, and other interested stakeholders.

Table 3.7–4. Waste Management Activities Under the Preferred Alternative for Treatment and Storage of TRUW

Generating Site[a]	Activity	Location	Receives Waste	Ships Waste to[c]
ANL-E	Treatment	Onsite		
	Storage	Onsite		
ETEC	Treatment	Onsite		
	Storage	Onsite		
Hanford	Treatment	Onsite		
	Storage	Onsite		
INEL	Treatment	Onsite	RFETS	
	Storage	Onsite	RFETS	
LANL	Treatment	Onsite	Pantex, SNL-NM	
	Storage	Onsite	Pantex, SNL-NM	
LBL	Treatment	Onsite		
	Storage	Onsite		
LLNL	Treatment	Onsite		
	Storage	Onsite		
Mound	Treatment	Onsite		
	Storage	Onsite		
NTS	Treatment	Onsite		
	Storage	Onsite		
ORR[b]	Treatment	Onsite/offsite	SRS	CH-TRUW to SRS
	Storage	Onsite/offsite	SRS	CH-TRUW to SRS
Pantex	Treatment	Offsite		LANL
	Storage	Offsite		LANL
PGDP	Treatment	Onsite		
	Storage	Onsite		
RFETS	Treatment	Onsite/offsite		INEL
	Storage	Onsite/offsite		INEL
SNL-NM	Treatment	Offsite		LANL
	Storage	Offsite		LANL
SRS[b]	Treatment	Onsite/offsite	ORR	RH-TRUW to ORR
	Storage	Onsite/offsite	ORR	RH-TRUW to ORR
UofMO	Treatment	Onsite		
	Storage	Onsite		
WVDP	Treatment	Onsite		
	Storage	Onsite		

Notes: *CH-TRUW = contact-handled TRUW; RH-TRUW = remote-handled TRUW.* A blank cell indicates that a site either does not receive TRUW from other sites or does not ship TRUW to other sites.

[a] A site is listed if it currently manages TRUW or is expected to manage it in the future.

[b] Under the Preferred Alternative, ORR is a regional treatment center for RH-TRUW, and SRS is a regional treatment center for CH-TRUW.

[c] Storage of treated TRUW pending final disposition.

Table 3.7-5. Waste Management Activities Under the Preferred Alternative for Storage of Treated HLW

Generating Site[a]	Stores Waste at	Receives Waste	Ships Waste to[b]
Hanford	Hanford		
INEL	INEL		
SRS	SRS		
WVDP	WVDP		

Note: A blank cell indicates that a site either does not receive HLW from other sites or does not ship HLW to other sites.
[a] A site is listed if it currently manages HLW or is expected to manage it in the future.
[b] Storage pending ultimate disposition.

Table 3.7-6. Waste Management Activities Under the Preferred Alternative for Treatment of HW

Generating Site[a]	Treats Waste at	Receives Waste	Ships Waste to
ANL-E	Offsite commercial facility		Offsite commercial treatment facility
Fermi	Offsite commercial facility		Offsite commercial treatment facility
Hanford	Offsite commercial facility		Offsite commercial treatment facility
INEL	Organic HW onsite, other HW at offsite commercial facility		Offsite commercial treatment facility
KCP	Offsite commercial facility		Offsite commercial treatment facility
LANL	Offsite commercial facility		Offsite commercial treatment facility
LLNL	Offsite commercial facility		Offsite commercial treatment facility
ORR	Organic HW onsite, other HW at offsite commercial facility		Offsite commercial treatment facility
Pantex	Offsite commercial facility		Offsite commercial treatment facility
SNL-NM	Offsite commercial facility		Offsite commercial treatment facility
SRS	Offsite commercial facility		Offsite commercial treatment facility

Note: A blank cell indicates that a site either does not receive HW from other sites or does not ship HW to other sites.
[a] Sites analyzed in the WM PEIS are those 11 sites that generated more than 90% of DOE's HW in 1991.

Disposal of LLMW. The Department's preferred alternative at this time is to send its LLMW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW or LLMW disposal operations and, except for NTS and LANL, each has relatively large LLMW volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLMW the Department will need to dispose of, there is no need for additional candidate sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation costs that would not be needed at more arid sites. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLMW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLMW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Treatment of LLW. Each site with LLW would treat its waste onsite. Each site would perform minimum treatment on its wastes to prepare them for disposal, although DOE would allow each of its sites the flexibility to perform additional treatment if it would decrease costs and requirements for transportation by significantly reducing the volume of LLW requiring disposal. The potential environmental impacts of all alternatives for treatment of LLW evaluated in the WM PEIS are small. The impacts of DOE's preferred alternative for LLW are identified in Regionalized Alternative 3 as shown in Table 3.7–1, under which the potential impacts associated with minimum treatment of LLW at each site were analyzed, assuming regionalized disposal, as discussed below.

Disposal of LLW. The Department's preferred alternative at this time is to send its LLW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW disposal operations and, except for NTS, each has large waste volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLW the Department will need to dispose of, there is no need to establish additional sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, with correspondingly higher traffic accident fatalities, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation costs that would not be needed at more arid sites. However, a disposal configuration that included at least one eastern site and one western site would require less transportation and produce fewer fatalities from traffic accidents than an eastern-only or western-only configuration. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Treatment and Storage of TRUW. Most of the DOE's sites with TRUW would treat and store it onsite. Five sites would ship TRUW to other sites for treatment under the preferred alternative: Pantex would ship its de minimis amount of TRUW to LANL for treatment; RFETS would ship some of its TRUW to INEL for treatment; ORR would send its CH-TRUW to SRS for treatment; SRS would send its RH-TRUW to ORR for treatment; and SNL-NM would send its TRUW to LANL for treatment. This preference assumes that WIPP will require treatment to the waste acceptance criteria the Department has proposed to EPA for this geologic repository. DOE's preference could change if WIPP requires a different level of treatment. The Department would store its TRUW where it is treated pending a decision on its disposal or other disposition.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several of the Regionalized Alternatives as shown in Table 3.7–1. It provides for cost-effective management of TRUW, poses low potential risks to the public, and has relatively small environmental impacts. DOE's preference is consistent with the preferred alternative identified in the *Waste Isolation Pilot Plant Disposal Phase Draft Supplemental Environmental Impact Statement* (WIPP SEIS-II).

Storage of HLW. The Department's preferred alternative at this time is to store its HLW where the waste is treated pending a decision on its disposal or other disposition. Because it is impractical to ship liquid HLW for treatment, DOE had previously decided that each of the four sites with HLW (Hanford, INEL, SRS, and WVDP) will treat its own waste onsite.

The potential impacts of DOE's preferred alternative are presented under the Decentralized Alternative for HLW. This alternative minimizes the transportation of treated HLW, makes use of existing storage capacity at WVDP and SRS, and would cost less than regionalized or centralized storage. The potential environmental impacts of all alternatives for HLW evaluated in the WM PEIS are small.

Treatment of HW. DOE's preferred alternative for HW is the No Action Alternative, which means the Department would continue to use commercial facilities to treat most of its non-wastewater HW. The transportation and environmental impacts are low for all of the alternatives for HW evaluated in the WM PEIS; however, the No Action Alternative costs less than the Decentralized or Regionalized Alternatives for HW treatment.

3.8 Use of Commercial or Privatized Facilities

After Records of Decision are issued, particular sites may propose to use commercial or privatized facilities for waste management activities. Such proposals would be analyzed in sitewide or project-specific NEPA documents. This WM PEIS does not preclude the use of waste management facilities constructed and operated by private entities on DOE sites at DOE's direction.

3.9 Comparison of Alternatives

A comparison of the alternatives analyzed for each waste type can be found in Chapters 6 through 10.

3.10 Alternatives Not Evaluated in Detail in the WM PEIS

Only DOE sites were analyzed as potential locations for waste management facilities in this PEIS. Other Federal sites (e.g., Department of Defense sites) were not considered to be reasonable alternatives. DOE prefers to avoid introduction of radioactive waste at DOE and other Federal sites where none exists. However, the WM PEIS does consider (at a conceptual level) the use of commercial and privatized waste management facilities for all waste types, including facilities at sites that may be purchased or leased from other Federal agencies.

The WM PEIS analysis does not assume the use of commercial waste management facilities across the Department except for hazardous waste because commercial capabilities for other waste types are limited. There are no commercial facilities for HLW or TRUW treatment, storage, or disposal. Nothing in the WM PEIS precludes a site from considering privatization or the use of commercial waste management facilities, since sitewide or project-level NEPA reviews of proposals for waste management may include alternatives for use of commercial vendors.

DOE analyzed representative alternatives ranging from management of wastes at all of the sites (the Decentralized Alternatives) to management at one site (the Centralized Alternatives) as potential locations for waste management facilities. CEQ has indicated that, when there are a very large number of possible reasonable alternatives, "... only a reasonable number of examples, covering the full spectrum of alternatives, must be analyzed and compared in the EIS" (CEQ, 1981). DOE believes that the

Regionalized Alternatives selected for analysis in this PEIS are representative of the numerous permutations between the Decentralized and Centralized Alternatives.

Chapter 3
Reference

Council on Environmental Quality (CEQ). 1981. "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations." *Federal Register* (March 23), p. 18026.

CHAPTER 4
Affected Environment

In this chapter, summary information is presented to characterize the pertinent environmental conditions at the U.S. Department of Energy (DOE) sites potentially affected by implementation of the various waste management alternatives (see Chapter 3). This chapter focuses on the 17 major DOE sites where most waste is located and where the waste management actions that have the potential to cause significant impacts will occur. The chapter describes the methodology and assumptions used to define and characterize each important aspect of the affected environment and summarizes the affected environment at the 17 major sites. The chapter includes short descriptions of other DOE sites with waste management activities considered part of the overall WM program. Detailed information on the affected environments at the DOE sites is provided in the Waste Management Programmatic Environmental Impact Statement (WM PEIS) Technical Report on Affected Environment (DOE, 1996).

4.1 Introduction

In accordance with the Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations (40 CFR 1508.14) on preparing an environmental impact statement, the affected environment is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." Characterization of the affected environment defines the baseline conditions against which the impacts of the various alternatives—including the No Action Alternative—are assessed. All data presented in this chapter are in summary form. Therefore, the length of the discussion is not intended to indicate the significance of the potential effects.

4.2 Approach to Defining the Affected Environment

In this PEIS DOE examines a range of broadly defined waste management alternatives potentially affecting many DOE sites located throughout the country. DOE focused the analysis of environmental impacts on the environment of and around individual sites that would have major roles in the DOE waste management program and defined the regions at each of these sites where different types of impacts were likely to occur.

Shipping wastes for treatment or disposal between sites, as well as shipping HLW and TRUW to their respective repositories, as proposed under the alternatives may affect the environment along connecting road or rail corridors. However, specific waste shipping routes are not being selected in this PEIS, so the ultimate shipping routes are not known at this time and could not be analyzed. As a basis for estimating the human health risks of transportation, DOE used representative road and railway routes. Human population densities along the representative routes were used to estimate population doses in the transportation risk assessment, but DOE did not otherwise attempt to characterize the affected environment along transportation routes.

4.2.1 MAJOR SITES

To determine the scope of the environmental impacts analysis for the WM PEIS, DOE reviewed the quantities of waste expected to be generated or currently in inventory at all the sites where DOE has management or other contractual responsibility for wastes. DOE determined that 54 sites (Figure 4.2–1) generate or have in inventory substantial quantities of radioactive or hazardous waste. These 54 sites constitute the set of sites at which waste management activities would be conducted under the proposed action. For a list of the waste types managed at each site, see Table 1.6–1 in Chapter 1. The Waste Isolation Pilot Plant (WIPP), although not yet in operation, is counted as one of the 54 sites because DOE plans to use WIPP to provide permanent disposal for TRUW. For a list of estimated quantities of LLMW, LLW, TRUW, HLW, and HW to be managed at each site, see Table 1.6–2 in Chapter 1.

Of the 54 sites, 17 were designated as major sites (see Figure 4.2–1) for detailed impacts analysis in this WM PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite, (2) they are candidates to host disposal facilities, (3) they manage HLW, or (4) they were included to be consistent with the Federal Facility Compliance Act process. The major sites contain the bulk of the five waste types, have capability for future disposal of LLW or LLMW, or have existing or planned major waste management facilities. The potential environmental impacts that could arise from treating, storing, and disposing of wastes at these major sites are considered in detail in this WM PEIS. Actions at the remaining sites are not evaluated in detail. Although WM actions will occur at the other 37 sites, DOE does not expect significant impacts to occur from those actions nor would those actions otherwise affect the programmatic decisions to be made subsequent to the PEIS.

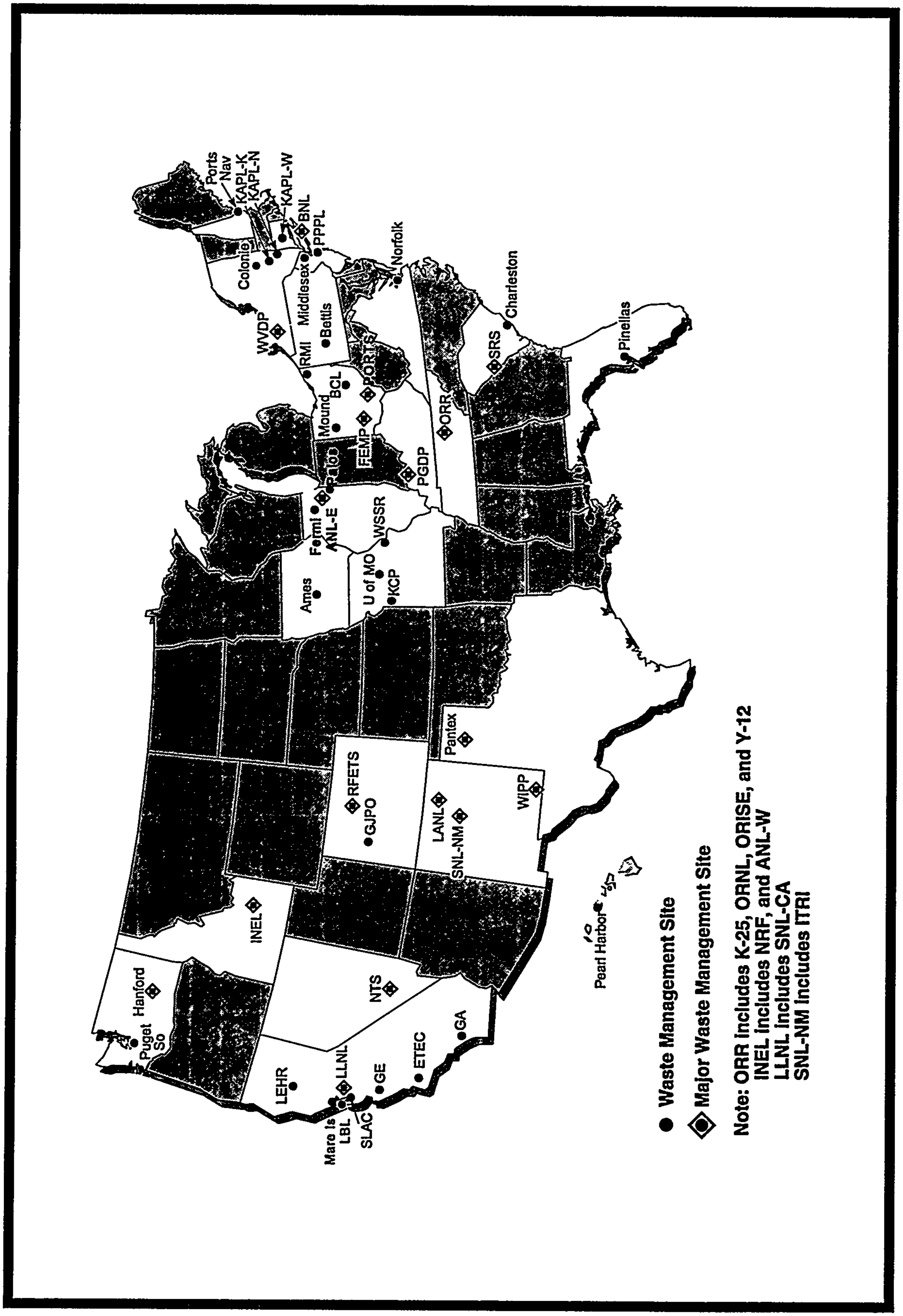

Figure 4.2–1. Waste Management Sites Considered in the WM PEIS

4.2.2 Regions of Influence

DOE evaluated the direct, indirect, and cumulative environmental impacts of the waste management alternatives within defined regions of influence (ROIs) or regions of impact at each of the 17 major sites and along waste transportation routes. ROIs at each site were specific to the type of effect evaluated and encompassed geographic areas within which DOE could reasonably expect to capture in its PEIS analysis any potentially significant impact of the WM program actions that might occur. For example, human health risks to the general public from exposure to waste management facility airborne contaminant emissions were assessed for an area either within a 50-mile radius of a generic WM facility assumed to be centrally located at each smaller DOE site or within a 50-mile radius of an existing WM location at each larger DOE site (i.e., Hanford, INEL, LANL, NTS, ORR, and SRS). The human health risks of shipping wastes between sites were evaluated for populations living along the road and railway corridors linking the DOE sites. Economic effects, such as job and income growth, in the regions surrounding each site were evaluated within a socioeconomic ROI that included the site host county, adjacent counties, and other nearby counties in which a substantial portion of each site's work force resides. The overall economic impact of DOE expenditures for all site activities and all waste shipments under each WM alternative was evaluated within the national economy. Brief descriptions of the impact-specific ROIs are given in Table 4.2–1.

At each of the 17 major sites, a baseline condition for each environmental resource area was determined from existing data and from information provided in previous environmental studies, relevant laws and regulations, and other government reports and databases (see Section 4.3). Table 4.2–2 summarizes certain data related to the ROI features at the 17 major sites used in the waste management impact analyses.

The health risk ROI populations differ from the socioeconomic ROI populations in Table 4.2–2 because they are based on different areas; the former are estimates of population within a 50-mile radius of each site's center and the latter are calculated by summing county populations for all counties in the socioeconomic ROI.

4.3 Affected Environment Resources Areas

The environmental features that may be affected by the waste management alternatives described in Chapter 3 include human health as it is related to the level of radionuclide and radiation exposure; air

Table 4.2–1. WM PEIS General Regions of Influence

Environmental Feature	WM PEIS Region of Influence (ROI)
Human health	Includes the site and nearby offsite areas (within 50 miles of the site and the transportation corridors between the sites) where worker and general population radiation, radionuclide, and hazardous chemical exposure is likely to occur
Air quality	Includes the site and nearby offsite areas within local air quality control regions and the transportation corridors between the sites that could be affected by airborne emissions generated from WM activities
Water resources	Includes onsite and adjacent surface water bodies and groundwater that could be affected by WM activities
Geology	Includes geologic resources within the DOE site and offsite areas where geology may influence or be influenced by WM activities
Soils	Includes soils within the DOE site and offsite areas where soils may be affected by WM activities
Ecological resources	Includes the site, adjacent resource areas, and the transportation corridors between the sites where ecological communities, including sensitive habitats and sensitive species, could be affected by WM activities
Socioeconomic conditions	Includes the counties that contain or are contiguous to the site or part of the site, and counties in the area where at least 90% of site employees reside
Environmental justice	Includes the regions of influence for all health, environmental, and socioeconomic impacts as defined in this table, although the WM PEIS environmental justice analysis focused primarily on human health risks within 50 miles of the sites
Land use	Includes the site and the area immediately adjacent to the site
Infrastructure	Includes power, water supply, sanitary wastewater treatment facilities, and road systems on the site, those offsite utilities that currently provide support to the site, and local offsite infrastructure
Transportation (national)	Includes the population and areas of the road and rail network that would be affected by shipping radiological and hazardous waste between the 54 sites
Transportation (local)	Includes the road and rail network connections to the site from the national road and rail networks
Cultural resources	Includes the area within and adjacent to the site boundary that may be affected by the proposed action

Table 4.2–2. Summary Data for Waste Management Sites

Site	Symbol	Acreage	MEI Dose[a] (mrem)	Population Dose[b] (person-rem)	Site Work Force[c]	Health Risk ROI Population[d]	Socioeconomic ROI Population[e]
1. Argonne National Laboratory-East	ANL-E	1,500	0.0085	17.0	4,455	7,939,785	6,568,800
2. Brookhaven National Laboratory	BNL	5,263	0.11	2.7	3,557	5,738,554	2,609,212
3. Fernald Environmental Management Project	FEMP	1,050	0.0021	1.30	1,939	2,764,589	1,313,000
4. Hanford Site	Hanford	358,309	0.0037	0.60	14,394	377,645	409,200
5. Idaho National Engineering Laboratory	INEL						
Idaho National Engineering Laboratory	INEL	569,588	0.0015	0.030	11,813	153,061	196,039
Argonne National Laboratory-West	ANL-W	f	f		f		f
Naval Reactor Facility	NRF	f	f		f		f
6. Lawrence Livermore National Laboratory	LLNL						
Lawrence Livermore National Laboratory	LLNL	8,172	0.690	1.70	8,713	6,324,234	2,934,064
Sandia National Laboratory (California)	SNL-CA	g	g		g		g
7. Los Alamos National Laboratory	LANL	27,520	7.90	1.40	6,199	159,152	151,408
8. Nevada Test Site	NTS	864,000	0.012	0.0290	7,086	14,266	759,240
9. Oak Ridge Reservation	ORR	35,000	1.400	43.0	21,544	881,652	482,481
K-25 Site	K-25	1,500	h		h		h
Oak Ridge Institute for Science and Education	ORISE	340	h		h		h
Oak Ridge National Laboratory	ORNL	2,900	h		h		h
Y-12 Plant	Y-12	811	h		h		h
10. Paducah Gaseous Diffusion Plant	PGDP	3,425	0.0045	0.017	1,740	500,502	151,526
11. Pantex Plant	Pantex	10,080	i		2,891	265,185	194,123

Table 4.2-2. Summary Data for Waste Management Sites—Continued

Site	Symbol	Acreage	MEI Dose[a] (mrem)	Population Dose[b] (person-rem)	Site Work Force[c]	Health Risk ROI Population[d]	Socioeconomic ROI Population[e]
12. Portsmouth Gaseous Diffusion Plant	PORTS	4,003	0.260	3.0	2,386	639,602	204,136
13. Rocky Flats Environmental Technology Site	RFETS	6,500	0.0002	0.140	7,365	2,171,877	1,790,600
14. Sandia National Laboratories	SNL-NM						
Sandia National Laboratories (New Mexico)	SNL-NM	2,820	0.0034	0.020	8,596	610,714	722,138
Inhalation Toxicology Research Institute	ITRI	135	j		218		726,200
15. Savannah River Site	SRS	198,000	0.140	6.40	17,492	620,618	460,028
16. Waste Isolation Pilot Plant	WIPP	10,245	—	—	932	99,889	217,661
17. West Valley Demonstration Project	WVDP	220	0.0003	0.011	1,100	1,698,391	1,052,766

[a] Dose to maximally exposed individual (MEI) from emissions of airborne radionuclides excluding radon-220, which is not subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) limits (DOE, 1994a). Exposure at ANL-E including radon-220 = 0.24 mrem; exposure at FEMP including radon-220 = 51 mrem.
[b] Collective dose to health risk ROI population.
[c] The number shown represents only that portion of the site workforce residing in the socioeconomic region of influence.
[d] The population within 80 km (50 miles) of a site (ROI) which is considered at risk for health impacts.
[e] The population of the site host county, adjacent counties, and nearby counties which supply in aggregate 90% or more of the site workforce.
[f] Data included in INEL.
[g] Data included in LLNL.
[h] Data included in ORR.
[i] Exposure less than 0.0001 mrem/year.
[j] Data included in SNL-NM.

quality; water resources and water quality; geology and soils; ecological resources; socioeconomic conditions; land use; infrastructure; transportation; and cultural resources. The approach used for characterizing the affected environment for these resource areas at the 17 major sites is summarized below. The baseline year for the affected environment in this PEIS is the end of the 1992 calendar year. Some exceptions do exist for certain resource features, such as socioeconomic or population data, which are based on 1990 census data. These exceptions are based on the requirement to incorporate the best available data that are consistent for the 17 sites in the analysis. These exceptions are noted where applicable. In some instances there have been significant changes since 1992; for example, in "Site Work Force" data. Wherever more current data have been recommended by the site(s) concerned, an evaluation of the analytical affects of the difference(s) was made. If no substantive change in the impacts analysis would result, the data have not been changed. Additional information is contained in the WM PEIS Technical Report on Affected Environment (DOE, 1996).

4.3.1 Human Health

The release of radionuclides to the atmosphere from existing site actions and the potential exposure of the offsite public to these contaminants are the focus of the human health affected environment section. Data reported in this section include (1) the ROI population based on 1990 Census data, which consists of individuals living within a 50-mile (80-kilometer) radius of the sites; (2) the estimated existing condition collective radiological dose (in person-rem) for the ROI population; and (3) the estimated existing condition radiological dose (in rem) for a hypothetical maximally exposed individual (MEI) living within the offsite population. The MEI is an individual whose estimated dose is higher than that received by most members of the general population. The exposure estimates are presented in units of person-rem for population risk and rem for individual risk. The rem (roentgen equivalent man) is a measure of biological damage to living cells caused by radiation in any form. A millirem (mrem) is one-thousandth of a rem.

The airborne radiation dose estimates for the offsite populations and MEIs presented in this chapter were compiled from a DOE report entitled *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a). Note that these exposure estimates were developed using air dispersion models; they do not represent actual monitored or measured exposures. Additional exposure estimates, including monitored exposures and multimedia MEI exposure estimates presented in annual site environmental reports, are not included. However, this information is presented in the technical report on the affected environment (DOE, 1996). Only the airborne pathway exposure estimates are presented in this chapter, because inhalation of airborne contaminants released from waste treatment facilities is assumed to be the most important exposure pathway for the greatest number of individuals in offsite populations. Note also that only the air pathway exposure estimates presented in Chapter 4 are used in the cumulative impact analyses in Chapter 11 to characterize existing site conditions. The health risk estimates presented in Chapters 6 through 10 represent the incremental risk from the proposed waste management actions that would be added to the existing baseline risks at the sites. The cumulative health risks estimated in Chapter 11 include risks from existing operations, the incremental risks from WM actions, and risks from other DOE actions proposed at the sites. Risks from past DOE operations are not included in the cumulative risk analysis because only a limited amount of data are available. Although dose reconstruction studies are being conducted at a number of DOE sites, study results are available only for three sites: Hanford (Shipler et al., 1996), NTS (Thompson and McArthur, 1996), and RFETS (Ripple et al., 1996).

All members of the public are exposed to a variety of radiation sources, both natural and manmade, called background radiation. The average background radiation level in the United States is estimated to be 360 mrem per year. The natural sources include radon (55% of the total radiation exposure), cosmic rays (8%), terrestrial (8%), and internal (11%). The manmade sources are x-rays (11%), nuclear medicine (4%), consumer products (3%), and other sources (less than 1%). Natural background radiation is the largest contributor to the average radiation dose to individuals and is the most variable component of background radiation. The total annual dose from background radiation can range from 100 mrem per year for people who live on sandy soil at sea level, to nearly 1,000 mrem per year for people who live in stone houses at high elevations (NCRP, 1987; NRC, 1994).

The U.S. Environmental Protection Agency (EPA) regulations (40 CFR 61, Subpart H) set the National Emission Standards for Hazardous Air Pollutants (NESHAPs) for public exposure to airborne radioactive materials (other than radon), including emissions from DOE sites. The nonradon limit for airborne exposure is 10 mrem per year from all sources. DOE has established a 100 mrem dose for annual exposure to members of the general public from all sources and through all pathways as part of DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE, 1990). DOE radon emissions are regulated by 40 CFR 61, Subparts Q and T. To ensure that such limits are observed, filtration systems are installed. For example, high-efficiency particulate air (HEPA) systems are routinely used that are capable of trapping and retaining at least 99.97% of all nondispersed particulates of 0.3 μm in diameter or larger.

DOE issued a report summarizing the emission reports submitted by 38 DOE sites to EPA for calendar year (CY) 1992 (DOE, 1994a). The total atmospheric release of radioactivity from radionuclides from the 38 DOE sites subject to the EPA reporting requirement was approximately 250,000 curies during 1992 (248,000 curies, or 99% of the total emissions, were emitted from the 17 major waste management sites analyzed in the WM PEIS). This was a 44% reduction from the 1991 releases. Most sites demonstrated compliance with the 10 mrem per year "effective dose equivalent" (EDE) standard of 40 CFR 61, Subpart H, including contributions from radon emissions regulated separately under subparts Q and T. More than 70% of the sites reported doses to the MEI that were less than 1% of the standard. Los Alamos National Laboratory (LANL) reported the highest estimated dose, about 80% of the standard. Doses received by the MEI from the airborne pathway are included in Table 4.2–2.

4.3.2 Air Quality

In support of the air quality impact assessment, affected environment data were obtained to establish background pollutant concentrations, local meteorological conditions, and local air quality requirements. In addition to the air quality impact assessment, the data on local meteorology were used to support the emissions deposition modeling for health risk studies and studies to determine the toxicity to terrestrial wildlife from airborne releases.

The affected environment was characterized in terms of EPA primary and secondary ambient air quality standards for criteria air pollutants and other ambient standards established by each State. The criteria air pollutants are carbon monoxide, sulfur dioxide, particulate matter (particles with a diameter less than or equal to 10 micrometers), ozone, nitrogen dioxide, and lead. In addition to the national criteria pollutants, certain states have adopted State-regulated criteria pollutants, which are listed in the technical report on affected environment, for each of the DOE sites (DOE, 1996). In addition to the criteria air pollutants, National Emission Standards for Hazardous Air Pollutants (NESHAP) established by EPA were also considered. These hazardous pollutants include radionuclides and hazardous materials that may be associated with DOE operations. Applicability of EPA regulations for the prevention of significant deterioration (PSD) was also considered. The PSD regulations are established to maintain air quality in areas already in attainment of the National Ambient Air Quality Standards (NAAQS). Some DOE sites in PSD areas have obtained PSD permits.

The ROI for air quality includes the site, nearby offsite areas, and the transportation corridors between the sites that could be affected by airborne emissions generated from WM activities. For most air quality impacts, the ROI includes areas within a 50-mile (80-kilometer) radius of the site. Data on the existing air quality environment were obtained from monitoring stations located on the site, or as close to the site as possible. Sites within 62 miles (100 kilometers) of a national park, monument, seashore, wildlife refuge, or wilderness area were noted in order that a screening assessment of impacts to visibility in these Class I areas could be performed.

Another important aspect of the ROI is the attainment status of the EPA-designated air quality control region(s) in which the site is located. The EPA air quality control region does not necessarily correspond to the ROI and may be larger or smaller. The ROI itself may contain portions of more than one EPA region. To be conservative, if the site could affect the air quality in more than one air quality control region, the data from the region with the worst air quality were used.

Table 4.3–1 presents the criteria air pollutant attainment status within the EPA-defined air quality regions where the 17 major sites are located. In general, the region is in attainment for a particular criteria pollutant if monitored ambient levels are below the NAAQS for that pollutant. The region is a nonattainment area for a particular criteria air pollutant if monitored ambient levels are at or exceed the NAAQS for that pollutant. The fact that criteria air pollutant standards are exceeded in the region of many DOE sites is not presumed to be directly attributable to DOE activities, but represents a condition that exists in the region as a whole. As indicated in Table 4.3–1, pollutants of particular concern include carbon monoxide, ozone, and particulate matter. New projects, including DOE facilities, must conform with the attainment plans contained in the State Implementation Plans, which describe the procedures to attain and maintain compliance with EPA criteria air pollutant levels.

4.3.3 Water Resources

Surface and groundwater affected by or used in conjunction with site activities define the affected environment in terms of water resources. Water resource elements include surface water bodies and their watersheds, stormwater runoff, groundwater resources, aquifers, floodplains, and potable drinking water sources. EPA designated sole-source aquifers and Federal Wild and Scenic Rivers are identified when near a DOE site.

Table 4.3–1. Criteria Pollutant Attainment Status at the 17 Major Sites

Site	State	NAAQS Attainment Status[a]					
		CO	NO_2	O_3	Pb	PM_{10}	SO_2
ANL-E	IL	A	A	S-17	A	MOD	A
BNL	NY	A	A	S-17	A	A	A
FEMP	OH	A	A	MOD	A	A	A
Hanford	WA	A	A	A	A	A	A
INEL	ID	A	A	A	A	A	A
LANL	NM	A	A	A	A	A	A
LLNL	CA	A	A	A	A	A	A
NTS	NV	MOD-2	A	A	A	MOD	A
ORR	TN	A	A	A	A	A	A
PGDP	KY	A	A	MAR	A	A	A
PORTS	OH	A	A	A	A	A	A
Pantex	TX	A	A	A	A	A	A
RFETS	CO	MOD-2	A	TRANS	A	MOD	A
SNL-NM	NM	MOD-1	A	A	A	A	A
SRS	SC	A	A	A	A	A	A
WIPP	NM	A	A	A	A	A	A
WVDP	NY	A	A	A	A	A	A

Notes: CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; PM_{10} = particulate matter ≤10 micrometers; SO_2 = sulfur dioxide; A = attainment; nonattainment codes: S-17 = severe-17; MOD-2 = moderate-2; MOD-1 = moderate-1; MOD = moderate; MAR = marginal; TRANS = transitional.

[a] Attainment status based on 1992 data except for LLNL, which were updated with 1995 data.

In support of the water resources impact assessment, data were obtained to establish baseline water usage, including use of municipal water, surface water and groundwater, as appropriate. Major stream flows were identified where they were used as a water source or received effluent discharge from the site. The site National Pollutant Discharge Elimination System (NPDES) permits, where applicable, are briefly described and the status of compliance with permit limits is summarized. Significant known surface water, sediment, and groundwater contamination are also described.

Contamination of surface water, stream sediment, and groundwater has occurred to varying degrees at most of the DOE sites; however, contamination is usually limited to onsite areas. Most contamination is related to past practices that have been discontinued. The type of contamination varies by site, depending on the activities that occurred. The following is a partial summary of the known water resource contamination:

Known surface water contaminants include:

- Cesium at NTS and ORR
- Plutonium at LANL, NTS, and ORR
- Strontium at the Hanford Site, LANL, ORR, and WVDP
- Tritium at the Hanford Site, NTS, ORR, and SRS
- Uranium at FEMP, the Hanford Site, and ORR

Known sediment contaminants include:

- Cesium at the Hanford Site, ORR, and SRS
- Mercury at ORR
- Plutonium at LANL and SRS
- Uranium at ORR, Paducah, FEMP, and Portsmouth

Known groundwater contaminants include:

- Cesium at the Hanford Site and SRS
- Plutonium at the Hanford Site, NTS, and RFETS
- Strontium at BNL, the Hanford Site, INEL, ORR, and SRS
- Technetium at the Hanford Site, ORR, and Paducah
- Tritium at BNL, the Hanford Site, INEL, LBL, LLNL, ORR, and SRS
- Uranium at FEMP, RFETS, and SRS
- Solvents at BNL, the Hanford Site, INEL, LBL, LLNL, ORR, Paducah, Portsmouth, RFETS, and SRS

4.3.4 Geology and Soils

Geology and soils are not likely to be affected by the WM actions. However, geologic and soil characteristics will factor into siting decisions when specific facility locations are selected. Elements of geology include topography, geologic formations, geologic structures, volcanic hazards, seismicity, and mineral deposits. Soil characteristics include type, permeability, porosity, susceptibility to subsidence, and erodibility. The geology and soils baseline assessment included identification of (1) the seismic risk, (2) soil characteristics, and (3) soil contamination that could affect health risk.

Most of the DOE sites are in stable geologic areas. The greatest seismic risks at the 17 major sites are believed to be at LLNL and Paducah. No DOE site is in an area of known substantial volcanic hazards. Subsidence (soil instability) is generally not a problem at the DOE sites, although slope failures may occur in association with seismic events.

For most DOE sites, the site's topography is such that sufficient buildable area exists without limiting construction and operation of new facilities. Most DOE sites have soils that are adequate for normal bearing loads encountered with limited height facilities; these soils are not prone to liquefaction or excessive erosion. In general, no unique deposits of minerals have been identified or are expected to be found at any DOE site; sand and gravel deposits occur at some sites. The Acquired Lands Act of 1947 prohibits mineral exploration and development at DOE sites, and most lands under DOE control have been closed to mineral exploration.

Varying degrees of soil contamination occur at many DOE sites. Most soil contamination is related to accidental spills or past practices that have been discontinued, and contamination is usually confined to onsite areas. The type of contamination varies by site and depends on the activities that occurred and the materials handled. Contaminants include radionuclides, organic compounds, and metals. Examples of known soil contamination include:

- Cesium contamination at the Hanford Site and ORR
- Plutonium contamination at the Hanford Site, NTS, INEL, and RFETS
- Strontium contamination at the Hanford Site
- Uranium contamination at FEMP, NTS, Paducah, the Pantex Plant, and Portsmouth
- Solvent (organic) contamination at LBL, LLNL, the Pantex Plant, and SRS

4.3.5 Ecological Resources

Ecological resources include terrestrial communities (including recreational wildlife and significant forestry), aquatic communities (including recreational fishing), wetlands, threatened and endangered species, and biodiversity. Many sites, particularly the larger sites, such as the Hanford Site and SRS, support diverse communities of plants and animals. Some sites, such as RFETS, support habitats that are biologically more diverse than the surrounding landscape because they have remained protected from grazing, farming, and development. Construction site clearing, excavation, and access road building for new waste treatment, storage, and disposal facilities may disturb or remove portions of the natural habitats at the sites, depending on where the new facilities are located. In support of the ecological resources impact assessment, affected environment data were obtained from site environmental reports to determine the presence of Federal and State threatened and endangered (sensitive) species on the sites. Table 4.3–2 provides a summary of the threatened and endangered species that have been identified at the major DOE waste management sites. Additional information is presented in the affected environment technical report (DOE, 1996).

4.3.6 Socioeconomic Conditions

Socioeconomic elements include population size, demographics (age, sex, and race), site employee residence patterns, current employment, unemployment, and income and earnings by industry. The variables used as baseline data to calculate impacts include employment, per capita income, and population for 1990. Per capita income is multiplied by population to calculate total personal income. Employment and personal income are used as baseline variables from which percent changes due to waste management activities are calculated. Regional industry multipliers (the change in the economy in response to a change in expenditure) were determined for the socioeconomic ROIs of the major sites. In support of the socioeconomic impact analysis, data were also obtained to establish employee residence patterns and housing and demographic characteristics. The housing data considered are occupancy and vacancy rates, and number of housing units. Baseline socioeconomic data were obtained from the U.S. Department of Commerce (DOC), Bureau of the Economics Analysis (BEA), and the Bureau of the Census (DOC, 1991, 1992a-c).

As noted in Table 4.2–1, the ROI for socioeconomics consists of the site host county, all contiguous counties, and those nearby counties where, in aggregate, at least 90% of the site workforce currently resides. In addition, baseline data were collected for the nation as a whole. The nationwide data were developed to provide a baseline for the comparison of employment, income, and industrial output by alternative nationally.

Table 4.3–2. Federal and State Threatened and Endangered Species at the 17 Major Sites

Site	Federal and State Threatened and Endangered Species[a]
ANL-E	Species potentially occurring—1 Federal Endangered (mammal), 1 Federal Threatened (insect), 3 State Endangered (1 bird, 1 mammal, 1 plant), 2 State Threatened (1 reptile, 1 plant)
BNL	Species occurring onsite—1 Federal Endangered (bird), 1 Federal Threatened (bird), 2 State Endangered (1 bird, 1 amphibian), 4 State Threatened (birds)
FEMP	Species occurring or potentially occurring—2 Federal Endangered (1 mammal, 1 plant), 3 State Threatened (1 bird, 1 crustacean, 1 plant), 7 State Endangered (1 amphibian, 3 birds, 1 mammal, 2 plants)
Hanford[b]	Species occurring—1 Federal Endangered (bird), 2 Federal Threatened (2 birds), 7 State Endangered (4 birds, 2 plants, 1 mammal), 4 State Threatened (2 birds, 2 plants)
INEL	Species occurring—1 Federal Endangered (bird), 1 Federal Threatened (bird), 2 State Endangered (2 birds)
LLNL[c]	Species potentially occurring—5 Federal Endangered (2 invertebrates, 1 mammal, 1 bird, 1 plant), 1 Federal Threatened (1 invertebrate), 2 State Endangered (1 bird, 1 plant), 3 State Threatened (1 reptile, 1 mammal, 1 bird)
LANL	Species occurring—1 Federal Endangered (bird), 1 Federal Threatened (bird), 4 State Endangered (1 plant, 2 birds, 1 amphibian)
NTS	Species occurring—1 Federal Endangered (bird), 1 Federal Threatened (reptile), 2 State Endangered (1 bird, 1 plant-critically endangered)
ORR	Species occurring—1 Federal Threatened (bird), 4 State Endangered (3 birds, 1 plant), 7 State Threatened (5 birds, 2 plants)
PGDP	Species occurring or potentially occurring in the vicinity—7 Federal Endangered (1 bird, 5 mollusks, 1 mammal), 2 Federal Threatened (1 bird, 1 mammal), 9 State Endangered (3 birds, 1 fish, 1 mammal, 4 mollusks), 3 State Threatened (2 plants, 1 reptile)
Pantex	Species occurring or potentially occurring in the vicinity—3 Federal Endangered (3 birds), 2 Federal Threatened (2 birds), 5 State Endangered (4 birds, 1 reptile), 3 State Threatened (2 birds, 1 reptile)
PORTS	Species occurring or potentially occurring in the vicinity—1 Federal Endangered (mammal), 4 State Endangered (1 mammal, 2 mollusks, 1 plant), 5 State Threatened (1 fish, 4 mollusks)
RFETS	Species potentially occurring—1 Federal Endangered (bird), 1 Federal Threatened (bird), 2 State Endangered (2 birds)
SNL-NM	Species potentially occurring—1 Federal Endangered (bird), 8 State Endangered (5 birds, 3 plants)
SRS	Species potentially occurring—6 Federal Endangered (4 birds, 1 fish, 1 plant), 2 Federal Threatened (1 reptile, 1 bird), 7 State Endangered (5 birds, 1 fish, 1 mammal), 1 State Threatened (bird)
WIPP	Species potentially occurring—1 Federal Endangered (1 bird), 1 Federal Threatened (1 bird), 4 State Endangered (4 birds), 1 State Threatened (reptile)
WVDP	Species potentially occurring—1 Federal Endangered (mammal), 4 State Endangered (1 bird, 1 mammal, 1 plant, 1 reptile), 4 State Threatened (2 birds, 1 plant, 1 reptile)

[a] This list covers species that are known to occur or may occur on the site or in the vicinity. Listings of common and scientific names are provided in the WM PEIS Technical Report on Affected Environment (DOE, 1996).
[b] Hanford policy is to treat 11 candidate species as if they were endangered (see site description).
[c] Includes Federal and State listed species from Site 300.

The site work force estimates and ROI population size data presented in Table 4.2–2 are used only in evaluating socioeconomic and site transportation infrastructure impacts. The health risk analyses use separate estimates of population sizes for the offsite population (based on a 50-mile radius for aerial dispersion of facility release), noninvolved worker population, and waste management worker receptor groups (see Sections 5.4.1 of Volume I and D.2.2 of Volume III).

4.3.7 Environmental Justice

Executive Order 12898, titled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies to incorporate environmental justice as part of their missions. As such, Federal agencies are specifically directed to identify and address as appropriate disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. The approach used to address the potential for these impacts in the WM PEIS first identified minority and low-income populations residing within 50 miles of the DOE sites, and then determined where and under what circumstances waste management impacts might be disproportionately high and adverse.

For each of the 17 major waste management sites, demographic maps were generated through a geographic information system that used 1990 census data available from the U.S. Bureau of the Census. These maps, which appear in Appendix C, are based on an analysis of 1990 United States Bureau of the Census Tiger Line files, which contain political boundaries and geographical features, and Summary Tape Files 1 and 3, which contain demographic information (DOC, 1992d,e). Data were resolved to the census tract level. A census tract is an area defined for the purpose of monitoring census data that is usually composed of between 2,500 and 8,000 persons. Figures C.4–1 through C.4–34 in Appendix C illustrate census tract distributions for minority and low-income populations residing within 50 miles of the 17 DOE sites being considered for the management of the five waste types.

Federally recognized Native American tribal lands within 50 miles of each site were also identified and mapped and are included in Appendix C, where applicable, with the minority distribution maps C.4–1 through C.4–17. Although not identified in the site summary section of this chapter (Section 4.4), nonfederally recognized Native American groups may also be present near DOE sites. DOE would consult with concerned Native American groups before taking actions under the WM PEIS at sites that have tribal involvement. Specifically, DOE will consult with tribal governments to assure that tribal rights, including treaty rights, are considered prior to making any site-specific decisions.

A ***minority population*** consists of persons classified by the U.S. Bureau of the Census as Negro/Black/African-American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, or other nonwhite, based on self-classification by the people according to the race with which they most closely identify. In order to avoid double-counting minority Hispanic persons (Hispanics can be of any race), only white Hispanics were included in the tabulation of racially based minorities. Nonwhite Hispanics had already been counted under their respective minority racial classification (e.g., Black, American Indian). For purposes of this analysis, a minority population consists of any census tract within the 50-mile zone of impact with a minority population proportion greater than the national average of 24.4%. A ***low-income population*** refers to U.S. Census Bureau data definitions of individuals living below the poverty line. The poverty line is defined by a statistical threshold that considers family size and income (see Appendix C). For purposes of this analysis, a low-income population consists of any census tract within the 50-mile zone of impact with a low-income population proportion greater than the national average of 13.1%.

Table 4.3-3 summarizes minority and low-income population data for the 50-mile zone of impact at each site. The percentage of population that is minority and low-income was calculated from actual counts that include, but are not limited to, the census tracts depicted in Appendix C. As the table indicates, 7 of the 17 sites have census tracts containing minority population proportions in their respective 50-mile zone of impact that exceed the national average of 24.4%. Of the 7 sites, 6 had minority proportions larger than 5% above the national average. However, 4 of these sites are in states (California and New Mexico) with minority population proportions well above the national average. For low-income populations, 8 of the 17 sites have census tracts containing low-income population proportions that exceed the national average of 13.1%. Of the 8 sites, 4 had low-income proportions larger than 5% above the national average. The site fact sheet sections on environmental justice in this chapter refer to Appendix C for the maps of minority and low-income populations that surround the sites. Appendix C also provides the data definitions and methods used to develop the maps.

Table 4.3–3. Demographic Data Related to Environmental Justice

Site	Population in the 50-Mile Impact Zone (millions)	Percent Minorities	Federally Recognized Native American Groups	Percent Below Poverty Level
ANL-E	8.03	33.5	None	11.4
BNL	5.26	21.4	None	5.4
FEMP	2.64	13.2	None	11.8
Hanford	0.35	25.8	Yes	18.8
INEL	0.11	10.2	Yes	12.5
LLNL	6.31	40.9	None	9.5
LANL	0.27	48.1	Yes	13
NTS	0.01	12.8	Yes	12.6
ORR	0.88	6.1	None	16.2
PGDP	0.50	9.1	None	19.1
Pantex	0.27	19.8	None	15.2
PORTS	0.61	3.2	None	20.8
RFETS	1.98	19.7	Yes	9.8
SNL-NM	0.61	45.1	Yes	14.8
SRS	0.59	37.8	Yes	18
WIPP	0.10	30.9	Yes	21.6
WVDP	1.54	11.6	Yes	12.2

4.3.8 Land Use

In support of the land use impact assessment, information on total site acreage, land utilized for existing structures, land suitable for waste management operations (excluding land set aside for sensitive species, wetlands, floodplains, or land with other limitations or designated uses), land designated for future waste management operations, and site development plans were obtained. The land use baseline for each site was defined by using U.S. Geological Survey maps, and DOE environmental reports and development plans.

Table 4.3–4 presents the total acreage at each site and the estimated acreage available for the 17 major sites. Site acreage data were compiled from *DOE Real Property: A Yearly Statistical Handbook Fiscal Year 1993*, (DOE, 1994b). The "Available Acres for Waste Management Facilities" (column 3) were obtained from site development reports when available. For those sites without a designated waste management area, this value was computed by subtracting the land currently used and the land unavailable from the total acreage.

Table 4.3–4. Land Available for Facilities at the 17 Major Waste Management Sites

Site	Total Acreage	Available Acres for Waste Management Facilities
ANL-E	1,500	1,190[a]
BNL	5,263	2,900
FEMP	1,050	275
Hanford	358,309	6,000
INEL	569,588	22,330
LLNL	8,172	7,849
LANL	27,520	16,187
NTS	864,000	640,000
ORR	35,000	5,629
PGDP	3,425	2,675[a]
Pantex	10,080	7,713
PORTS	4,003	3,203
RFETS	6,500	5,753
SNL-NM	2,820	206
SRS	198,000	145,400
WIPP	10,245	10,210
WVDP	220	165

[a] Data shown were available at the time of computations. The Chicago Operations Office has since reported that fewer acres are available for waste management facilities and that much of the operations will be performed in existing facilities which will be converted to the required technologies. Subsequent information also indicates that fewer acres would be available for waste management facilities at PGDP.

Established buffer zones, untenable terrain (e.g., wetlands, canyons), and land committed to planned projects are examples of land unavailable. These exceptions are noted in further detail on a site-specific basis in Section 4.4. Specific site selection for facilities proposed by this PEIS would be addressed by project-level EISs prepared for the sites concerned.

4.3.9 Infrastructure

Infrastructure elements include the site's potable water supply, wastewater treatment system, electrical power systems, and transportation network. In support of the infrastructure impact analysis, data were obtained to establish baseline capacities for the site potable and process water supply, process and sanitary wastewater treatment, and electrical power. The site hazardous and toxic waste treatment and disposal systems (nonradiological) are considered as part of the hazardous waste alternatives analyses and are not discussed here.

In general, water and wastewater treatment systems are located on site. Potable water is supplied from deep wells or from surface water systems, which frequently require some type of chemical treatment. A few sites dispose sewage in a municipal system. However, most DOE sites have their own disposal facilities. Many of the onsite landfills for the DOE sites have closed, and the sites have contracts with public or private landfills. In many cases, offsite electrical power companies are connected to onsite substations. For example, the Hanford Site is supplied by the Bonneville Power Administration. Some sites have limited onsite electrical power generation capability; however, the equipment is usually used only for backup or in emergency situations.

Table 4.3–5 lists the water, wastewater, and power infrastructure features at the 17 major sites that have potential limitations on increased usage related to implementing the waste management alternatives. The transportation infrastructure at each site is briefly described in Section 4.4.

4.3.10 TRANSPORTATION

4.3.10.1 National Transportation

Transportation elements include the number of rail and truck shipments to and from DOE sites and the local transportation network in the vicinity of the individual sites. In support of the impact analysis, data on DOE's rail and truck shipment traffic were obtained.

In addition, the national transportation environment was established in terms of the applicable government regulations and DOE policy related to transporting radiological and other hazardous material, general risk criteria, and the methodology for determining national transportation routes. The current DOE traffic volumes and associated accidents, packaging of materials, and emergency response preparedness are also presented.

Table 4.3-5. Infrastructure Use and Capacities[a]

Site	Water		Wastewater		Power	
	Total Capacity (mgd)	Total Current Use (mgd)	Total Capacity (mgd)	Total Current Use (mgd)	Total Capacity (MW)	Peak Load (MW)
ANL-E	1.8	0.645	1.8	1.08	*	23
BNL	6	4.5	2.3	1.0	47	35
FEMP	1.6	0.4	2.27	2.18	33	30
Hanford	79.06	9.51	0.2	0.158	352	59
INEL	30.96	5.242	1.0	0.254	55	42
LLNL	2.52	0.717	1.68	0.4	100	61
LANL	10	4.1	1	*	120	68
NTS	2.78	1.36	0.338	0.14	45	30
ORR	40.2	18.3	0.92	0.64	660	116
PGDP	30	15	1.75	0.4	3,040	1,564
Pantex	1.5	0.5	0.545	0.275	1,523	13
PORTS	37	14	1.2	0.35	1,929	1,537
RFETS	1.0	0.272	0.5	0.15	35	18
SNL-NM	4.03	1.0	*	0.548	50	35
SRS	5.0	1.6	0.75	0.5	*	130
WIPP	0.54	0.075	0.0185	0.012	9.4	4.6
WVDP	0.11	0.07	0.07	0.07	6.5	2.9

Notes: mgd = million gallons per day; MW = megawatts; * = value unknown.
[a] Data for baseline infrastructure represent onsite use only. Wastewater use and capacity are based on sanitary waste. No process wastes are involved.

Shipping radiological and other hazardous material from DOE sites to interstate highways or a rail terminus is described for each site in the WM PEIS Technical Report on Affected Environment (DOE, 1996). Air and barge transport are not considered in this PEIS.

The selection of a regional or centralized waste management alternative will potentially result in the transport of large quantities of radioactive waste on the nation's highways. In conducting transportation campaigns, DOE will adhere to applicable Federal regulations to ensure that the waste is transported safely and that the potential for impacts to the public and environment is minimized. These regulations cover the packaging, handling, and transporting of radioactive and hazardous material. DOE has adopted these regulations as part of DOE Order 1450.1C.

All transportation routes used for shipping radiological and other hazardous material have been derived from the HIGHWAY program model (ORNL, 1993a) and the INTERLINE model (ORNL, 1993b), which consider population densities along the routes. These models choose transportation routes between shipping-receiving combinations in accordance with U.S. Department of Transportation (DOT) routing constraints for transporting radiological and other hazardous materials, with maximum use of interstate highways and rail lines and minimum travel time and distance. Population density distributions were calculated along the routes used in this PEIS to compute health risk consequences. Results of transportation analyses are contained in the chapter for each waste type, Chapter 11, and Appendix E.

Transportation mode and routing decisions will be made on a site-specific basis during the transportation planning process. Sites can use the transportation analyses in this WM PEIS to make site-specific transportation decisions or, if necessary, conduct additional transportation analyses. DOE proactively works with states, regional entities, and carriers during large shipping campaigns to ensure that safe routing alternatives and safe havens are utilized.

Data for DOE radiological and hazardous materials shipments were obtained from the DOE Shipment Mobility/Accountability Collection (SMAC) information system (Morris, 1994, 1995). These data represent most, but not all, of the DOE transportation activities related to the shipment of radioactive waste material.

On the national level, about 100 million packages classified as hazardous materials (flammables, explosives, poisons, and radioactive material) are shipped each year (NRC, 1977). A more recent radioactive materials transport study stated that, excluding DOE shipments, approximately 2 million shipments of radioactive materials consisting of 2.79 million packages are made each year (SNL, 1985).

For FY 1993, radioactive and other hazardous material shipments accounted for 4.5% (27,698) of all DOE shipments and 32.6% of the tonnage. Of these shipments, 33.3% (9,231) contained radioactive material, and 13.3% (3,695) contained a combination of radioactive and other hazardous material.

For more than 40 years, radioactive materials have been shipped in the United States with no known adverse health effects due to accidental releases. Information about accidents involving radioactive materials has been collected over a 23-year period through September 1993 (SNL, 1993). During that period, 349 air, highway, and rail transportation accidents occurred. Of these accidents, 307 were highway, 20 were rail-related, and the remaining 22 were air-related. Packages used for shipping quantities or types of radioactive materials that could have serious consequences if released are designed to withstand accident conditions. Accidents involving these packages have resulted in no release of radioactive materials. The Nuclear Regulatory Commission (NRC) has concluded that at least half of the radiation exposure resulting from shipments of radiological materials would be received by transportation workers, but the doses would be below allowable limits (NRC, 1977). The NRC also concluded that exposure from accidents was about 10 times less significant than the normal operational exposure (as determined by a statistical prediction of the number of latent cancer fatalities).

Because health and safety consequences may possibly result from an accident involving radioactive or other hazardous material, DOE will allocated resources and has established training on emergency response under the overall Federal Emergency Response Program to mitigate the effects of such an accident. Under this program, DOE was directed by Congress in Section 180 of the Nuclear Waste Policy Act (42 USC 10101-10270) to provide assistance and funds to States training public safety officials of local governments. The Federal Emergency Management Agency (FEMA) coordinates peacetime radiological accident response (as directed in the FEMA regulation 44 CFR 351).

The ROI for transportation is the ROI for the national transportation environment which is the population and areas associated with the road and rail network that would be affected by shipping radiological and hazardous material between the 54 sites that could be affected by implementing the waste management alternatives discussed in Chapter 3.

Tables 4.3–6 and 4.3–7 provide the number of current rail and truck shipments to and from the major DOE sites on the basis of the 1993 Shipment Mobility/Accountability Collection (SMAC) and the Waste Manifest System FY 1993 (Morris, 1994, 1995). This database includes all radioactive material shipments, not just waste shipments. The sites report the data for incoming and outgoing shipments of all hazardous material. Hazardous materials containing a radioactive component are listed as "radioactive" and provided in both the "Incoming" and "Outgoing" columns. The remaining hazardous materials not containing a radioactive component are shown in the "Other Hazardous" columns.

Table 4.3-6. DOE Truck Shipments of Hazardous Materials to or From Major Waste Generating and Storage Sites During Fiscal Year 1993

	Incoming				Outgoing			
	Radioactive[a]		Other Hazardous[b]		Radioactive[a]		Other Hazardous[b]	
Site	Shipments[c]	Wt (lb)[d]	Shipments[c]	Wt (lb)[d]	Shipments[c]	Wt (lb)[d]	Shipments[c]	Wt (lb)[d]
ANL-E	15	244,013	0	0	93	1,089,798	2	646
BNL	3	1,860	0	0	5	95,560	0	0
ETEC	1	150	0	0	25	981,643	0	0
FEMP	1	5,787	3	20,000	445	16,454,993	3	96,068
Hanford	113	3,063,760	0	0	18	358,682	2	4,830
INEL	22	317,828	2	646	36	881,145	4	1,167
KAPL-K	24	388,347	0	0	25	452,810	1	14
LBL	1	4,820	0	0	12	250,166	0	0
LLNL	9	6,872	8	7,544	5	8,875	9	12,309
LANL	18	20,491	8	43,759	9	8,059	2	43
Middlesex	0	0	0	0	0	0	0	0
NTS	449	16,518,680	2	886	5	15,303	5	32,153
ORR	197	387,269	49	1,216,790	843	23,140,823	44	548,573
PGDP	895	22,621,065	16	284,341	101	3,610,839	9	93,728
Pantex	72	971,011	9	1,627	163	353,142	8	8,248
PORTS	107	3,831,089	24	199,232	153	1,130,976	31	979,820
RFETS	4	5,418	2	641	17	144,100	1	70
SNL-NM	5	25,470	2	4,794	1	1,035	3	2,164
SRS	39	676,679	0	0	19	112,660	1	5
WIPP[e]	0	0	0	0	0	0	0	0
WVDP	0	0	0	0	0	0	0	0
Total	1,975	49,090,609	125	1,780,260	1,975	49,090,609	125	1,779,838

[a] Includes all types of radioactive materials, as well as any radioactive waste.
[b] "Other hazardous" refers to all hazardous materials except those that are radioactive.
[c] Reflects shipments to and from DOE sites.
[d] Weight includes shipping containers.
[e] Site not reporting to SMAC in fiscal year 1993.

Source: Based on DOE waste shipments as reported to the Shipment Mobility/Accountability Collection (SMAC) (Morris, 1994, 1995).

Table 4.3-7. DOE Rail Shipments to or From Major Waste Generating and Storage Sites During Fiscal Year 1993

Site	Incoming				Outgoing			
	Radioactive[a]		Other Hazardous[b]		Radioactive[a]		Other Hazardous[b]	
	Shipments[c]	Wt (lbs)[d]	Shipments[c]	Wt (lbs)[d]	Shipments[c]	Wt (lbs)[d]	Shipments[c]	Wt (lbs)[d]
ANL-E	0	0	0	0	0	0	0	0
BNL	0	0	0	0	0	0	0	0
ETEC	0	0	0	0	0	0	0	0
FEMP	0	0	0	0	0	0	0	0
Hanford	0	0	0	0	0	0	0	0
INEL	0	0	0	0	0	0	0	0
KAPL-K	0	0	0	0	0	0	0	0
LBL	0	0	0	0	0	0	0	0
LLNL	0	0	0	0	0	0	0	0
LANL	0	0	0	0	0	0	0	0
Middlesex	0	0	0	0	0	0	0	0
NTS	0	0	0	0	0	0	0	0
ORR	0	0	0	0	8	995,658	13	2,307,000
PGDP	106	8,566,763	7	1,217,100	117	18,992,927	0	0
Pantex	0	0	0	0	0	0	0	0
PORTS	117	18,992,927	6	1,089,900	98	7,571,105	0	0
RFETS	0	0	0	0	0	0	0	0
SNL-NM	0	0	0	0	0	0	0	0
SRS	0	0	0	0	0	0	0	0
WIPP[e]	0	0	0	0	0	0	0	0
WVDP	0	0	0	0	0	0	0	0
Total	223	27,559,690	13	2,307,000	215	27,559,690	13	2,307,000

[a] Includes all types of radioactive materials and radioactive waste.
[b] "Other hazardous" refers to all hazardous materials except those that are radioactive.
[c] Reflects shipments to and from DOE sites.
[d] Weight includes shipping containers.
[e] Site not reporting to SMAC in FY 93.

Source: Based on DOE waste shipments as reported to the Shipment Mobility/Accountability Collection (SMAC) (Morris, 1994, 1995).

4.3.10.2 Local Transportation

All major sites analyzed in the WM PEIS have local road and, in some cases, rail connections to the site. Details of these road and rail connections are described in the WM PEIS Technical Report on Affected Environment (DOE, 1996) and summarized in Section 4.4 for each site.

4.3.11 CULTURAL RESOURCES

Cultural resources include archaeological remains, historically significant architecture, traditional cultural properties, and a variety of resources significant to contemporary Native American cultures. Paleontogical resources, although not cultural in origin, are also included because of their recognized value and similar need for protection. Information regarding known cultural resources at the 17 major DOE sites is presented in Table 4.3–8. Information on the extent to which each site has been surveyed is also provided. No assumption with respect to the presence or absence of additional resources is made for areas not surveyed. Additional cultural resource surveys would be required for this purpose. For additional information regarding Native American cultural resources, see Sections 1.4.1 and 5.4.10.

Archaeological remains include both prehistoric and historic sites and both buried and standing remains, including artifacts, architecture, and botanical and zoological remains associated with Old-World-derived and Native American cultures.

In the United States, historic resources date to the period after European contact. Archaeological and architectural properties of sufficient significance and integrity are eligible for inclusion in the National Register of Historic Places (NRHP). Impacts to eligible sites located on Federal land must be considered, whether or not they are listed on the NRHP.

Cultural resources important to Native American groups include burials, artifacts, structures, areas of religious importance, and traditional natural resources including plants, animals, and land forms such as mountains or bodies of water. Impacts to these resources located on Federal land must also be considered.

The cultural resource baseline was based on DOE environmental reports. Inquiries were also sent to the State Historic Preservation Officers (SHPOs) with jurisdiction over the 17 major sites. Many of these sites

Table 4.3–8. Status of Known Sites With Regard to the National Register of Historic Places

Site	Acreage in FY 1995 FAAQ	Acres Inventoried[a]	Percent Inventoried	Historic and Archeological Sites				
				NRHP	NRHP Eligible	NRHP Ineligible	Awaiting Determination	Not NRHP Evaluated
ANL-E	1,700	1,700	100	0	3	20	23	ND
BNL	5,325	0	0	0	3	0	0	0
FEMP	1,150	700	61	0	3	39	ND	ND
Hanford	358,400	21,358	6	49	84	15	0	883
INEL	568,820	26,237	5	1	1	2	0	1,708
LLNL[b]	7,640	ND	ND	0	0	--0	0	28
LANL	27,869	15,327	55	0	280	95	777	253
NTS	864,812	53,395	6	1	150	652	1,160	x
ORR	34,700	5,882	17	0	15	31	0	0
PGDP	3,423	1,361	40	0	0	3	1	2
Pantex	15,936	7,100	45	0	0	0	23	64
PORTS	3,714	0	0	0	0	0	0	0
RFETS	6,550	6,550	100	0	0	64	0	0
SNL-NM	2,830	2,830	100	0	0	0	0	0
SRS	298,000	51,818	17	0	55	116	208	827
WIPP	10,240	3,416	33	0	0	ND	33	ND
WVDP[c]	X	X	X	X	X	X	X	X

Notes: FAAQ = Federal Archaeological Activities Questionnaire; ND = no data provided by the facility in the FY 1995 FAAQ; X = no response provided by the facility in the FY 1995 FAAQ.

[a] Acres inventoried sufficiently to identify all readily apparent archaeological properties.

[b] Most recent data available are from FY 1992.

[c] While the West Valley Demonstration Project has not responded to the Federal Archaeological Activities Questionnaire, an archaeological survey covering 360 acres was conducted in 1990. As a result of this survey, nine archaeological sites were discovered, none of which has been listed in the National Register (NRHP), and a model predicting the likelihood of sites over the remainder of the site has been developed (DOE, 1996).

Source: Information provided by DOE's Federal Preservation Officer, Office of Environmental Policy and Assistance (based on the FY 1995 Archaeological Activities Questionnaire) (FAAQ).

have not been completely surveyed for cultural resources. These surveys would be required for any new construction associated with waste treatment, storage, and disposal facilities.

4.3.12 SAFEGUARDS AND SECURITY

DOE has a Safeguards and Security (S&S) Program to protect DOE interests from theft or diversion of special nuclear material; sabotage, espionage, loss or theft of classified matter or government property; and other hostile acts that may cause unacceptable adverse impacts on national security or on the health and safety of employees, the public, or the environment. Because radioactive and hazardous waste mishandled with malicious intent could cause adverse safety and health impacts, the Safeguards and Security Program applies to waste management, in addition to other material that presents greater safeguards and security risks. DOE's planning and preparedness for operational emergencies recognizes hostile attack, terrorism, sabotage, and malevolent acts as events that should be considered as possible initiators of operational emergencies. Operational emergency plans address coordination with Federal, state, tribal, and local organizations to locate and recover materials, especially those with national security implications. Of the types of waste considered in this PEIS, transuranic waste probably has the greatest safeguards and security implications because it contains plutonium, a special nuclear material.

4.4 Affected Environment at the Major Sites

This section contains a summary of the most pertinent facts characterizing the affected environment and defining the ROI for each of the 17 major sites. Each site is first described in terms of its location, mission, and brief history. This is followed by resource area-specific information. While useful at the programmatic level, this information will be supplemented by detailed analyses in sitewide or project-level NEPA reviews. Tables 3.6–1 through 3.6–5 provide a summary of which sites are considered under each alternative for each waste type.

4.4.1 ARGONNE NATIONAL LABORATORY-EAST—CHICAGO, ILLINOIS

Argonne National Laboratory-East (ANL-E), a 1,500-acre site located 22 miles southwest of downtown Chicago in northeast Illinois, is an outgrowth of the Metallurgical Laboratory established in 1942 as part of the Manhattan Project. The mission of this 4,670-employee research and development laboratory is to conduct programs in basic energy and related sciences. ANL-E is an important engineering center for the study of nuclear and nonnuclear energy sources. ANL-E is shown in Figure 4.4–1.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 7,939,785 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0085 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a). If radon is included, the dose is 0.24 mrem.
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 16.8 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- ANL-E and the counties surrounding it are classified by EPA as severe nonattainment areas for the criteria pollutant ozone. Lyons Township in southeast Chicago is listed as a moderate nonattainment area for particulate matter less than 10 micrometers in diameter (PM_{10}). The areas are in attainment for the other criteria air pollutants.
- Major sources of air pollution at the site include a steam plant, oil-fired boilers, gasoline and methanol dispensing facilities, two alkali metal reaction booths, a small vapor degreaser, a number of bulk chemical tanks, a dust collection system, a medical equipment sterilization unit, fire training activities, a combustion and power generation research facility, laboratory ventilation systems for hot cell facilities, and ventilation systems for active and inactive reactors and particulate accelerators.
- Prevailing winds are from the south and southwest with a significant northeast component. The frequency of calm winds is 3%. Average monthly temperatures of 27.9 to 68.5 degrees Fahrenheit (°F) were recorded in 1992. Precipitation for the year was 31.5 inches.

Water Resources

- Major surface water features include Lake Michigan (24 miles east), the Des Plaines River (1.25 miles southeast), and the onsite Sawmill Creek. The Freund Brook drains most of the site.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- Sanitary and laboratory wastewaters are combined, treated, and discharged to Sawmill Creek, which drains into the Des Plaines River.

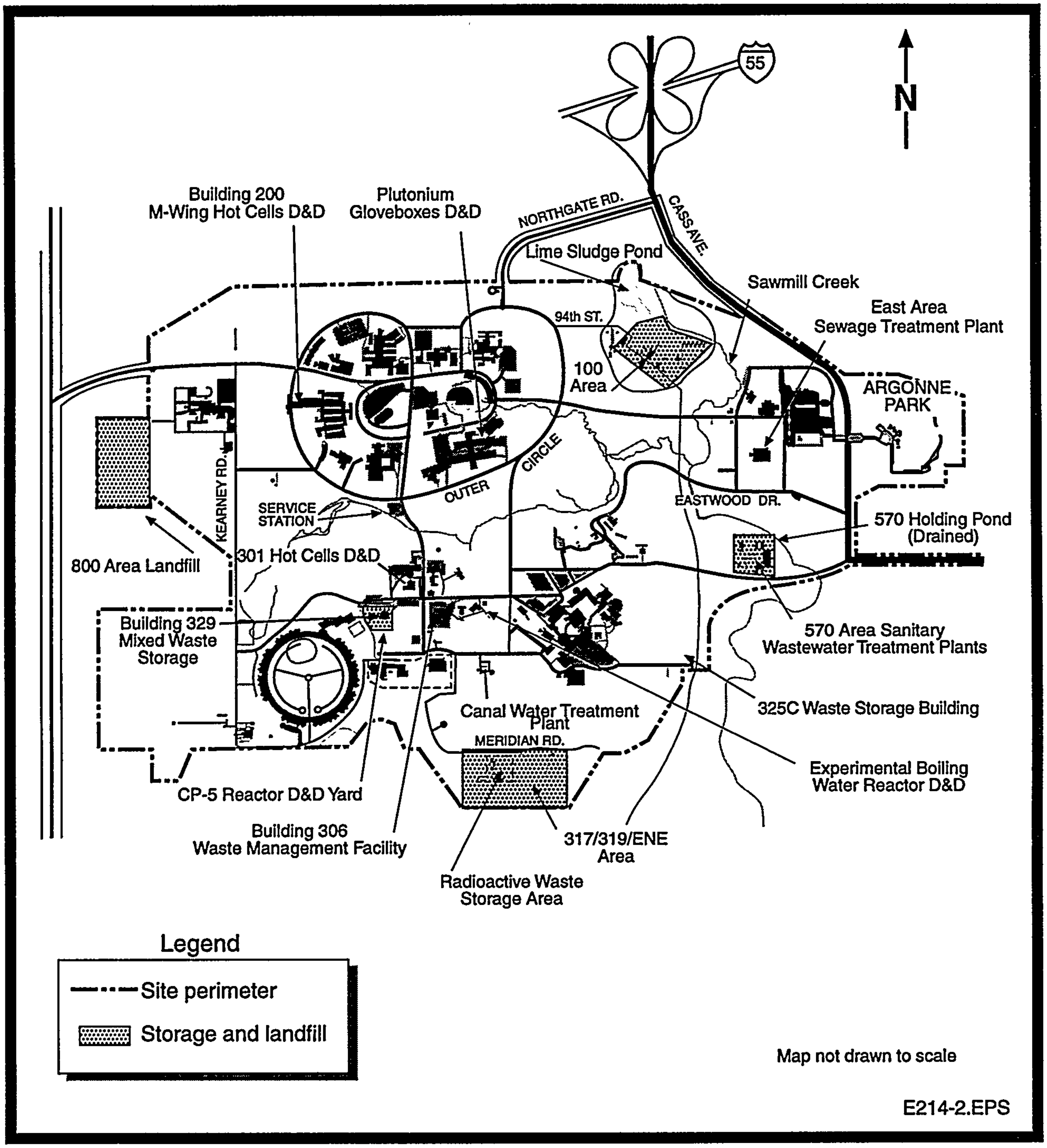

Figure 4.4–1. Argonne National Laboratory-East

- In 1993, all radionuclides measured in Sawmill Creek were a small fraction of the DOE-derived concentration guides.
- Water for the site is supplied by groundwater from the Niagara Aquifer.
- Major groundwater units include, from deep to shallow, the Galesville Sandstone, the Maquoketa Shale aquitard, and the Niagara and Alexandria Dolomite. No sole source aquifers exist beneath the site.
- Five commonly monitored groundwater contaminants exceeded comparison criteria in 1990.
- Site facilities are outside of the 500-year floodplain.

Geology and Soils

- The topography of the site is gently rolling, with an average elevation of about 725 feet above sea level.
- Major rock units include, from oldest to youngest, the Galesville Sandstone, the Maquoketa Shale, and the Niagara and Alexandria Dolomite.
- Glacial till is approximately 30 to 100 feet thick and overlies nearly horizontal sedimentary rocks.
- Most soils at the site are moderately well-drained silt loams with slopes ranging from 2% to 10%.
- Geologic hazards include little or no risk from earthquakes or volcanos. A few minor earthquakes have occurred in the northern Illinois area; these are believed to be caused by isostatic adjustments of the Earth's crust in response to glacial unloading.

Ecological Resources

- Vegetation communities are a mixture of open field, deciduous forest, pine plantation, and tall-grass prairie. Much of the natural vegetation in the ANL-E area has been altered by clearing and tillage. The 2,040-acre Waterfall Glen Forest Preserve surrounds ANL-E.
- Wetlands total 3.56 acres and consist of cattail marsh and wooded swamp. Adjacent wetlands are present in Waterfall Glen Forest Preserve.
- Federally listed threatened or endangered species are not known to reside on the ANL-E site. The Black Crowned Night Heron (*Nycticorax nycticonax*) is a State-listed endangered species residing onsite. The Federally endangered Indiana Bat (*Myotis sodalis*) and the Federally threatened Hine's Emerald Dragonfly (*Somatochlova hineana*) reside in the area and may possibly reside on the ANL-E site. Two State-endangered species, River Otter (*Lutra canadensis*) and White Lady's Slipper (*Cypridedium candidum*), and two State-threatened species, Kirtland's Snake (*Clonophis kwitlandi*) and Sedge (*Carex crawei*) reside in the area and may possibly reside on the ANL-E site.

Socioeconomic Conditions

- The ROI for ANL-E comprises Du Page, Cook, Kane, and Will Counties. Approximately 95% of the site's employees reside in these counties.
- Total site employment in 1990 was 4,455. Total ROI employment by place of work in 1990 was 3,883,841.
- The ROI unemployment rate in 1991 was 6.7%.
- The ROI per capita income in 1990 was $22,169.
- The total population in the ROI in 1990 was 6,568,800. Population demographics: Native Americans—0.2%; urban—97.4%.
- Housing: owner-occupied—59.4%; renter-occupied—40.6%.
- Sensitive populations: children (under 15 years old)—21.7%; women of child-bearing age (ages 15 to 44)—24.2%, adults over 65—11.6%.

Environmental Justice

- Minorities—Figure C.4–1.
- Below poverty level—Figure C.4–24.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site covers an area of 1,500 acres, of which about 30% is developed; approximately 1,190 acres are available for development.
- The Waterfall Glen Forest Preserve, adjacent to the site, is used for skiing, hiking, and equestrian sports.
- The area immediately outside the preserve is predominantly single-family residential.

Infrastructure

- Four onsite wells provide an average of 0.645 million gallons of water per day.
- An onsite facility receives an average of 1.08 million gallons of sewage per day.
- Commonwealth Edison Company supplies power to the site; the current site load is 23 megawatts.
- Interstate I-55 provides direct access to the site from Chicago and Joliet. Interstates I-88, I-355, I-80, and I-294 are other major roads providing access to ANL-E. Local roads include Illinois Route 83, U.S. Route 45/20, and U.S. Route 34. The Santa Fe, Burlington Northern, Conrail Corporation, Union Pacific, Illinois Central, and CSX are among the major rail lines that ANL-E has access to.

Cultural Resources

- Native American groups lived in the region surrounding ANL-E from approximately 10,000 years ago until the beginning of Euro-American settlement during the early 19th century.
- Within ANL-E, 46 archaeological sites have been recorded. Of these, 23 await determination of eligibility for the National Register of Historic Places.
- Three archaeological sites within ANL-E are eligible for the National Register.

4.4.2 BROOKHAVEN NATIONAL LABORATORY—UPTON, NEW YORK

Brookhaven National Laboratory (BNL) is located in Upton, New York, 60 miles east of New York City, in the center of Suffolk County. The contract for the 5,263-acre site was approved by the Manhattan District of the Army Corps of Engineers in 1947, and BNL was established on the former Upton Army camp. The mission for this 3,557-employee site is to conceive, design, construct, and operate large, complex-research facilities for fundamental scientific studies and to conduct basic and applied research in the physical, biomedical, and environmental sciences and selected energy technologies. BNL is shown in Figure 4.4–2.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 5,738,554 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.11 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 2.7 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Suffolk County, in which BNL is located, is classified by EPA as a nonattainment area for the criteria pollutant ozone. The county is in attainment for the other five criteria air pollutants.
- Primary sources of air emissions at the site include furnaces, vehicle refueling stations, and surface coating and surface preparation operations.

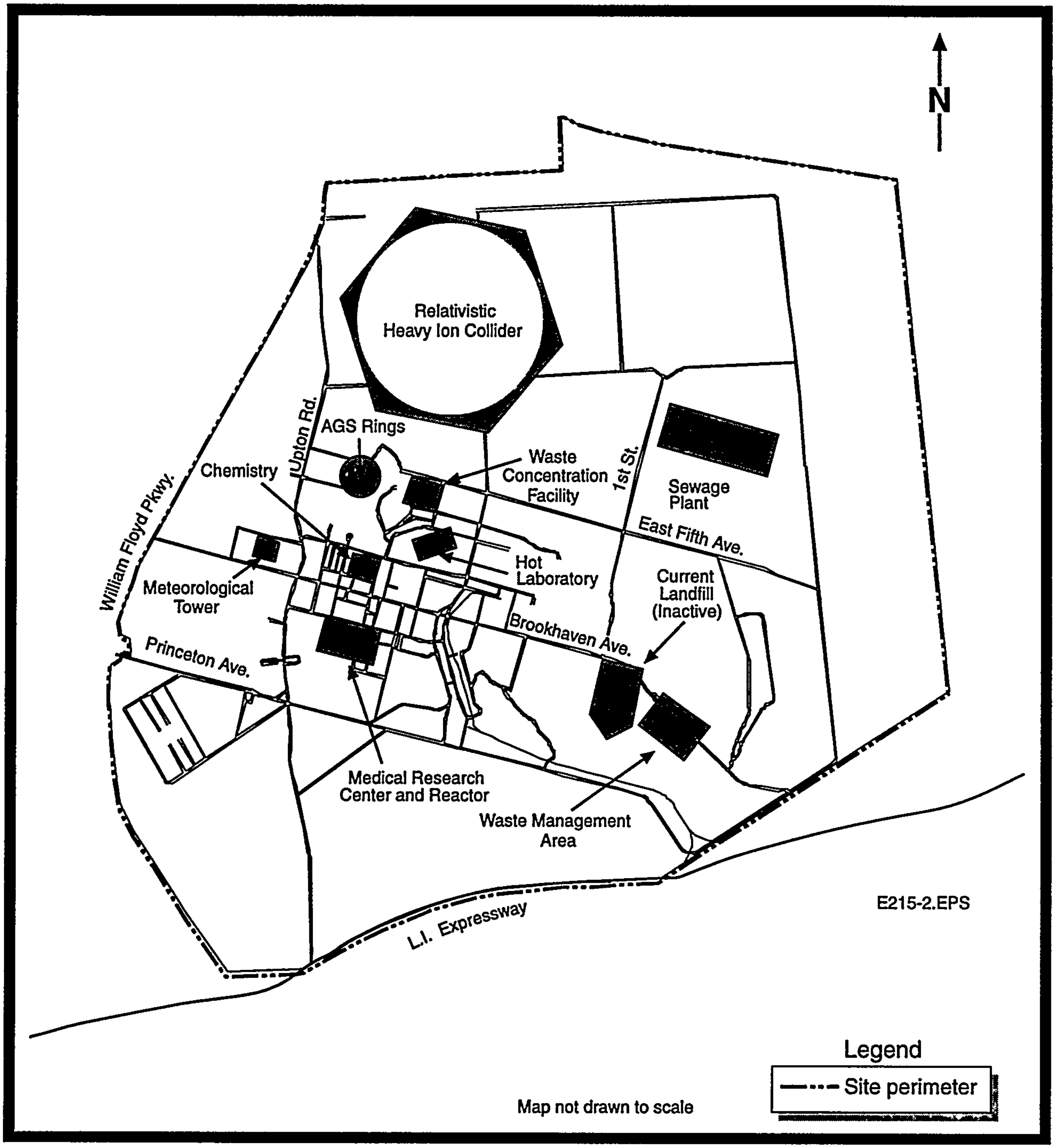

Figure 4.4–2. Brookhaven National Laboratory

- Prevailing winds in 1991 were from the south and southwest with a frequency of 12%. Dominant windspeed ranged from 8 to 11 miles per hour (mph) and occurred almost 34% of the time during 1991. The frequency of calm winds was 14%. Average monthly temperatures of 21.2 to 83.8 °F were recorded in 1991. Precipitation for the year was 45.3 inches.

Water Resources

- Major surface water features include the onsite Peconic River and its intermittent tributary.
- No federally designated Wild and Scenic Rivers exist in the ROI. A portion of the Peconic River that flows through the site has been designated "scenic" by the State of New York.
- Onsite streams and the Peconic River receive treated wastewater.
- Discharge monitoring in 1991 showed that all concentrations were within applicable standards, except for trichloroethylene.
- The Upper Glacial Aquifer and the Magothy Aquifer supply water for the site through 12 onsite wells.
- The major groundwater units are the lower aquifer system (Magothy and Raritan Formations) and the Pleistocene Upper Glacial Aquifer. These aquifers are considered sole source aquifers.
- Groundwater monitoring in 1991 showed that 8 parameters exceeded New York State Drinking Water Standards.
- Some groundwater contamination has migrated off site at concentrations that exceed drinking water standards.
- A portion of the BNL site is in the 100-year floodplain.

Geology and Soils

- The topography of the site is generally gently rolling, with elevations ranging from 43.6 to 120 feet above sea level.
- Major geologic units include, from oldest to youngest, the basement rocks, the Raritan Formation, the Magothy Formation, and surface glacial deposits.
- Glacial deposits include the Gardiners Clay, overlain by 170 feet of sand.
- Soils on the site consist of deep, well-drained to excessively drained, coarse-textured soils.
- Geologic hazards include little or no risk from earthquakes or volcanos.

Ecological Resources

- Vegetation at BNL includes pine plantation, moderately mature pitch pine/oak forest, predominantly deciduous forest, early successional shrub/sapling community, pine barren, shrub/sapling wetland, and lawn area. Approximately 75% of BNL is primarily woodland. Old-growth hardwood trees that are unusual in the region are located next to BNL. Unique habitats include coastal plain ponds and a coastal plain stream.

- Wetlands include palustrine forested, herbaceous, and lacustrine wetlands.
- Based on a survey of 15 ecological communities identified on or adjacent to BNL, the peregrine falcon is the only Federal and State-listed endangered species reported to occur onsite at BNL. The bald eagle, Federally listed as threatened, is also reported at BNL. State-listed species include 4 threatened (osprey, red-shouldered hawk, northern harrier, and common tern), 1 endangered (eastern tiger salamander), and 12 species of special concern. A wetland on BNL is a breeding area for the eastern tiger salamander. No Federal or State-listed endangered, threatened, or special concern plants are found on site at BNL. However, one Federal endangered plant, the sandplain gerardia, has been reported in the Brookhaven area (though not on or adjacent to the site), and five flowering plants and eight fern species found at BNL are protected under State law.

Socioeconomic Conditions

- The ROI for BNL comprises Suffolk and Nassau Counties. Ninety percent of the site's employees reside in these counties.
- Total site employment in 1990 was 3,557. Total ROI employment by place of work in 1990 was 1,419,040.
- The ROI unemployment rate in 1991 was 6%.
- The ROI per capita income in 1990 was $27,919.
- The total population in the ROI in 1990 was 2,609,212. Population demographics: Native Americans—0.2%; urban—97.9%.
- Housing: owner-occupied—80.28%; renter-occupied—19.72%.
- Sensitive populations: children (under 15 years old)—19.9%; women of child-bearing age (ages 15 to 44)—23.2%; adults over 65—12.4%.

Environmental Justice

- Minorities—Figure C.4–8.
- Below poverty level—Figure C.4–25.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site covers an area of 5,263 acres, of which 1,655 acres are developed. The site contains six designated, regulated wetlands and areas where the water table is close to the surface, that comprise an aggregate area of approximately 700 acres. Thus, approximately 2,900 acres are available for development.
- Land use surrounding the site is predominantly undeveloped private and public forest land but is experiencing intensified pressure for residential development. BNL is located in the Central Pine Barrens and within the Peconic Estuary system.

Infrastructure

- An onsite water treatment plant supplied by groundwater provides an average of 4.5 million gallons of water per day.
- An onsite plant receives an average of 1 million gallons of sewage per day, with the effluent discharged to the headwaters of the Peconic River.
- The Long Island Lighting Company supplies power to BNL; the current site load is 35 megawatts.
- Interstate I-495 provides direct access between BNL and New York City. The region surrounding BNL is served by the Long Island Railroad.

Cultural Resources

- BNL contains no recorded archaeological sites, standing structures, or traditional cultural properties. However, the site has not been the subject of a comprehensive cultural resource investigation.
- Three areas that have been identified as eligible for inclusion on the National Register of Historic Places.

4.4.3 Fernald Environmental Management Project—Fernald, Ohio

The Fernald Environmental Management Project (FEMP), formerly Feed Materials Production Center, is just north of Fernald, Ohio, a small farming community in southwest Ohio (about 17 miles northwest of downtown Cincinnati). In operation since 1952, the primary mission of the 1,050-acre FEMP was to produce purified uranium metal and uranium compounds for use at other DOE defense facilities. A small amount of thorium processing has also been conducted at FEMP. FEMP is shown in Figure 4.4–3.

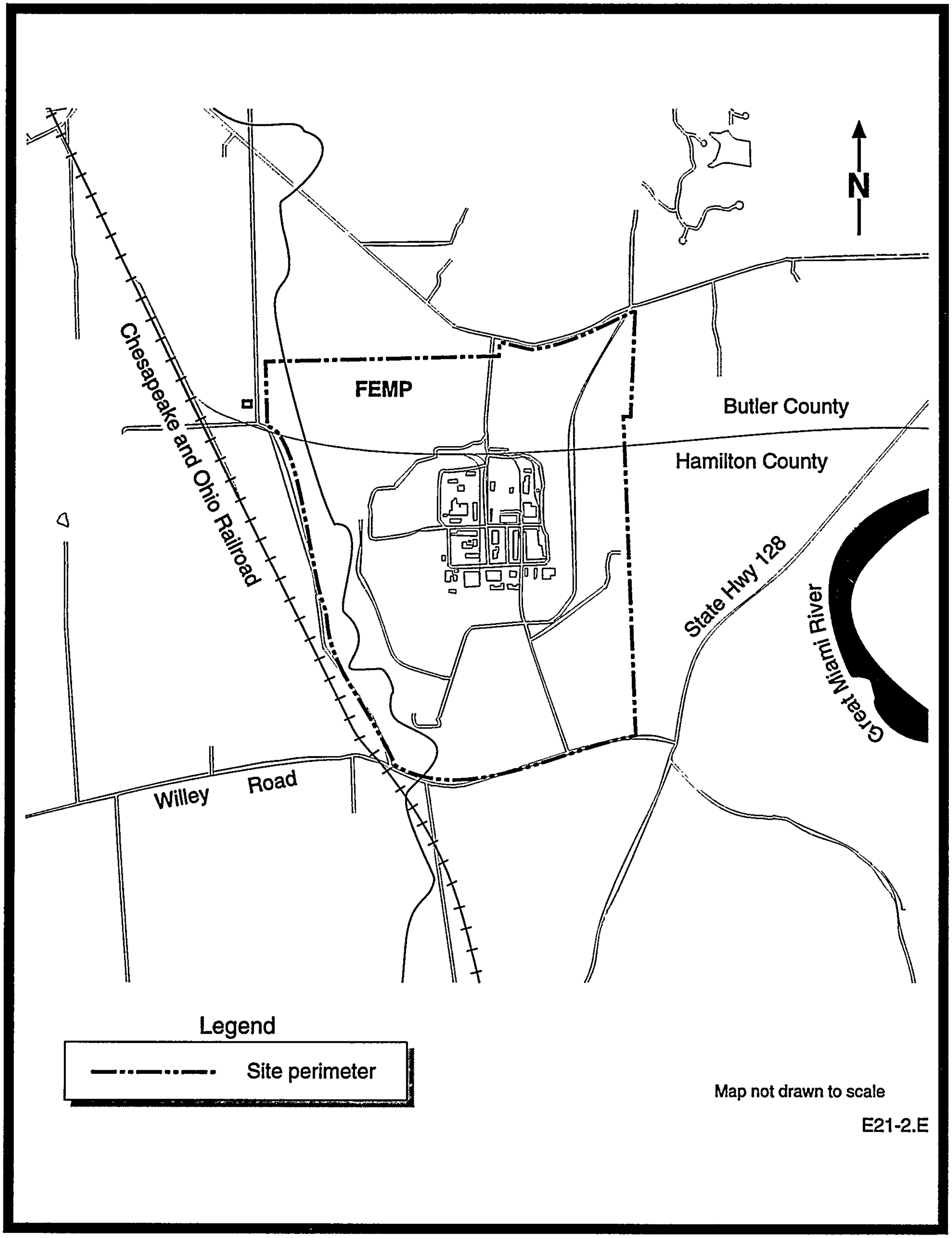

Figure 4.4–3. Fernald Environmental Management Project

By the late 1980s, production was suspended, and the site's mission was changed from uranium production to environmental restoration of the site. The 1,939 FEMP employees are now engaged in cleanup of the site and support of the waste management and base services activities.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 2,764,589 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0021 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a). If radon is included, the dose is 51 mrem.
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 1.30 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Hamilton and Butler Counties are classified as "moderate nonattainment" areas for ozone; these counties are in attainment for the remaining five criteria air pollutants.
- The major source of air pollution at the site is the boiler plant emissions.
- Prevailing winds are from the south southwest 12% of the time; calm winds occur 4% of the time. The annual average windspeed recorded at the Greater Cincinnati Airport was 9 mph with 1-minute sustained winds up to 46 mph. Average monthly temperatures of 32 to 88 °F were recorded in 1992. Precipitation for the year was 38 inches; the monthly maximum was 7 inches in July.

Water Resources

- Major surface water features include Paddy's Run, which drains the site to the Great Miami River, which then drains into the Ohio River.
- No federally designated Wild and Scenic Rivers exist downstream of the site.
- Wastewaters are discharged to onsite streams and the Great Miami River.
- Two parameters in the surface water exceeded comparison criteria in 1992.
- Groundwater from the Great Miami Buried Valley Aquifer supplies water for the site.
- The Great Miami Buried Valley Aquifer is a sole source aquifer.
- Eleven contaminants in the groundwater exceeded comparison criteria in 1992.
- The site is located above the 100-year floodplain of the Great Miami River.

Geology and Soils

- The site lies on a terrace remnant above the Great Miami River Valley. Glacial features dominate the landscape.
- Bedrock consists of sedimentary shales and limestone approximately 60 to 200 feet below the ground surface. The bedrock forms the floor and valley walls of the New Haven Trough.
- No major geologic faults have been mapped.
- The dominant soils at the site are silty loams of glacial origin. These soils are poorly drained, occur on relatively flat surfaces, have low permeability, and experience seasonal saturation.
- Geological hazards include little or no risk from subsidence, earthquakes, or volcanic eruptions.

Ecological Resources

- Vegetation consists of nonnative grasslands, pine plantations, deciduous woodlands, and riparian woodlands.
- Ecologically important habitat includes mature woodlands, pine for managed wildlife species, such as white-tailed deer and eastern cottontail rabbit, and riparian woodlands. Cattle grazing and brush clearing have resulted in habitat fragmentation and reduction in wildlife corridors.
- A total of 35.9 acres of freshwater wetlands (palustrine forested, drainage ditches/swales, and isolated persistent emergent and scrub/shrub wetlands) were delineated at FEMP.
- No Federally listed threatened or endangered plant or animal species are known at FEMP. However, potential habitat exists for the Indiana bat (Federal and State endangered). Running buffalo clover, a Federally listed endangered plant species, occurs near FEMP. Seven state-listed endangered species (including the Indiana bat) and three state-listed threatened species occur or potentially occur at FEMP.

Environmental Justice

- Minorities—Figure C.4–9.
- Below poverty level—Figure C.4–26.
- Presence of Federally recognized Native American Tribes: none.

Socioeconomic Conditions

- The ROI for FEMP comprises Hamilton, Butler, and Warren Counties in Ohio and Dearborn County in Indiana. Ninety percent of the site's employees reside in these counties.
- Total site employment in 1990 was 1,939. Total ROI employment by place of work in 1990 was 804,376.

- The ROI unemployment rate in 1991 was 6%.
- The ROI per capita income in 1990 was $19,275.
- The total population in the ROI in 1990 was 1,313,000. Population demographics: Native Americans—0.1%; urban—89.1%.
- Housing: owner-occupied—62.4%; renter-occupied—37.6%.
- Sensitive populations: children (under 15 years old)—23.8%; women of child-bearing age (ages 15 to 44)—23.9%; adults over 65—12.2%.

Land Use

- The site covers an area of 1,050 acres, of which 275 acres are developed; of the area that is undeveloped, 195 acres are considered environmentally sensitive. Land available for development is approximately 275 acres.
- Land use surrounding the site is predominantly agricultural.

Infrastructure

- An onsite well system provides an average of 0.4 million gallons of water per day. Connection to a public system is planned.
- An onsite wastewater treatment plant treats an average of 2.18 million gallons of sewage per day and discharges treated effluent into the Little Miami River.
- The Cincinnati Gas and Electric Company supplies power to the site; average loads are 33 megawatts.
- Transportation in the region consists of roads and interstates, such as nearby State Route 126. U.S. Route 27 provides access to Interstates 275 and 74. Rail access is by the Baltimore and Ohio Railroad, 3 miles to the west.

Cultural Resources

- Native American occupation of the FEMP area began about 14,000 years ago. European settlement began during the late 18th century.
- The site has 42 recorded archaeological sites, standing structures, or traditional cultural properties. Sixty-one percent of this site has been subject to a comprehensive cultural resources survey.
- Three areas are eligible for inclusion on the National Register of Historic Places.

4.4.4 HANFORD—RICHLAND, WASHINGTON

The Hanford Site occupies approximately 560 square miles of semi-arid desert land in southeastern Washington State, approximately 119 miles southwest of Spokane and 150 miles southeast of Seattle, and employs approximately 14,394 people. The Federal Government acquired the Hanford Site in 1943, and for almost 50 years, Hanford's facilities were dedicated to plutonium production and to the storage and disposal of the resulting waste products. Since the 1960s, however, programs at the Hanford Site have diversified to include research and development for advanced reactors, renewable energy technologies, waste disposal technologies, and cleanup of site contamination. The Hanford Site is shown in Figure 4.4–4.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 377,645 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0037 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.60 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Benton and Franklin Counties are classified as attainment areas for all six of the National Ambient Air Quality Standards criteria air pollutants. The southernmost portions of Benton, Franklin, and Walla Walla Counties (which do not include the Hanford Site) are suspected to be in nonattainment for particulate matter under 10 micrometers in diameter (PM_{10}), although they are not classified as nonattainment areas.
- Major sources of air pollution at the site are the 9 primary boiler units, the 300-Area incinerator, and fugitive emissions from the 200-East and 200-West coal piles.
- Prevailing winds are from the northwest during all months of the year, with monthly average speeds of 6 to 7 mph in the winter and 9 to 10 mph in the summer. Temperatures range from 36°F in early January to 95°F in late July. Annual average precipitation is 6.3 inches.

Water Resources

- Major surface water features include the onsite Columbia River and the nearby Yakima River. The Columbia River, which forms some of the site's eastern boundary, is regulated by a network of dams.

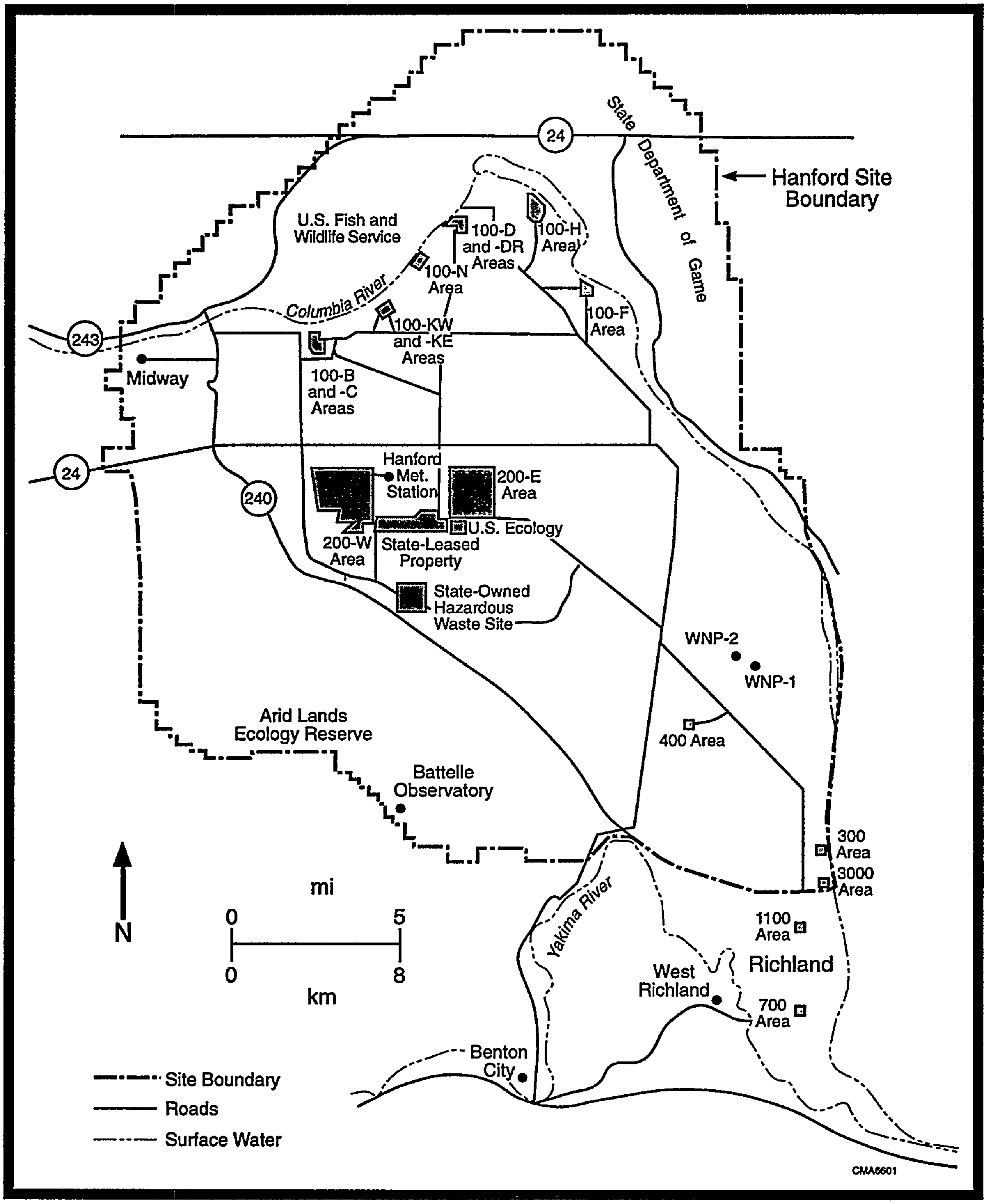

Figure 4.4–4. Hanford Site

- No federally designated Wild and Scenic Rivers exist in the ROI, although the Hanford Reach of the Columbia River has been recommended for inclusion in the Wild and Scenic Rivers System in the Record of Decision for the *Final Hanford Reach of the Columbia River Comprehensive River Conservation Study and Environmental Impact Statement* (DOI, 1994).
- The probable maximum flood would inundate parts of the 100-Area located adjacent to the Columbia River.
- The Columbia River and onsite wells supply water for the site.
- Treated wastewater is discharged to onsite drainfields and the Columbia River.
- Results from surface water monitoring in 1992 show five parameters exceeded comparison criteria.
- Unconfined aquifers contained within glaciofluvial sands and gravels and within the Ringold Formation and deeper confined aquifers within the Columbia River Basalts are the major groundwater units. No aquifers are considered sole source aquifers.
- Groundwater monitoring in 1992 showed that 14 parameters exceeded comparison criteria. Preliminary investigations have identified four major groundwater contaminant plumes, which have been found to enter the Columbia River in at least three locations.
- Lands susceptible to the 500-year flood on the Columbia River would be restricted to those areas of the site adjacent to the river. The 100-year flood on the Yakima River could extend into the southern section of the site.

Geology and Soils

- The site is on the intermontane Columbia Plateau, with the topography dominated by basalt plateaus, ridges, and buttes.
- Surface sediments consist of as much as 1,640 feet of unconsolidated sands, silts, gravels, and clays.
- Major rock units include—from oldest to youngest—flood basalts; the Ringold Formation consisting of unconsolidated fluvial sediments; the glacial Hanford Formation; and ash layers from Crater Lake, Oregon, Glacier Peak, Washington, and Mount St. Helens, Washington.
- Anticlines form surface highs in the region and are broken by faults on their crests. Steeply dipping shear zones are abundant in the region and extend to the northwest.
- Surficial soils vary from sand to silty and sandy loam but are predominantly deep, well-drained sandy loams. The Hanford formation near the Columbia River consists of coarse-grained soils composed mostly of the soil column above the basalt.

- The seismicity of the Columbia Plateau is relatively low. Shallow, low-intensity earthquakes occur throughout the Hanford Site area, although quakes of greater magnitude have occurred in the plateau region.

Ecological Resources

- The Hanford Site contains the largest tract of undisturbed native sagebrush steppe remaining in the State of Washington and is 6 linear miles from the second largest tract in the state, the Yakima Training Center. The National Biological Service has listed native shrub and grassland steppes in Washington and Oregon as an endangered ecosystem (Noss, 1995). This habitat also has been identified as a priority habitat by the State of Washington. There are 24 major plant communities (DOE, 1995). Big sagebrush and bitterbrush are important desert shrubs, and some plants have medicinal and dye value. Important terrestrial habitats include riparian areas, native shrub and grasslands, canyons, upland habitats, basalt outcroppings and cliffs, and trees that serve as nesting platforms for birds.
- Wetlands occur on the Hanford Site, with the largest wetland being the riparian zone bordering the Columbia River.
- The peregrine falcon (Federal and State endangered), the bald eagle (Federal and State threatened), and the Aleutian Canada Goose (Federal threatened, State endangered) are found on the Hanford Site. The peregrine falcon is a casual migrant to the Hanford Site and does not nest there. The bald eagle winters along the Hanford Reach. State-listed species include seven State endangered and four State threatened species. Eleven Federal candidate species (three are State threatened; two are State endangered; one is a State species of special concern; and two are State candidate species) have been observed. It is Hanford Site policy to treat candidate species in the same manner as listed species. An additional seven State candidate species have been found on the Hanford Site, as well as nineteen State plant species of concern. The Hanford Reach is the only significant mainstream spawning habitat remaining for Fall Chinook salmon. The Hanford Reach is the only significant remaining section of the inland Columbia River where White sturgeon are able to spawn. Three plant and seven insect species new to science have been discovered on the Hanford Site since 1994, indicating a very high-quality ecosystem.

Socioeconomic Conditions

- The ROI for the Hanford Site comprises Adams, Benton, Franklin, Grant, and Yakima Counties. Ninety-nine percent of the site's employees reside in these counties.

- Total site employment in 1990 was 14,394. Total ROI employment by place of work in 1990 was 214,298.
- The ROI unemployment rate in 1991 was 10.9%.
- The ROI per capita income in 1990 was $15,927.
- The total population in the ROI in 1990 was 409,200. Population demographics: Native Americans—2.5%; urban—50.1%.
- Housing: owner-occupied—63.1%; renter-occupied—36.9%.
- Sensitive populations: children (under 15 years old)—26.2%; women of child-bearing age (ages 15 to 44)—21.7%; adults over 65—11.8%.

Environmental Justice

- Minorities—Figure C.4–10a.
- Below poverty level—Figure C.4–27.
- Presence of Federally recognized Native American Tribes: Yakima Nation, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Confederated Tribes of the Warm Springs Indian Reservation.

  Tribal lands—Figure C.4–10b.

Land Use

- The site occupies approximately 560 square miles (358,300 acres) of arid desert land, of which 21,498 acres (6%) are developed. Of the undeveloped area, 77,000 acres have been set aside as an arid land ecology reserve, and an additional 89,000 acres (Wahluke Slope) are managed by the U.S. Fish and Wildlife Service and the Washington Department of Fish and Wildlife as a National Wildlife Refuge and Wildlife Area. Land area recommended for future waste management activities is 6,000 acres.
- The predominant land uses in the ROI are agriculture, the Yakima Indian Reservation, the Yakima Training Center (Department of Defense), and the Hanford Site.

Infrastructure

- Onsite wells and the Columbia River provide an average of 9.51 million gallons of water per day.
- Onsite treatment facilities (such as septic tanks, subsurface soil absorption systems, and a sanitary treatment plant) treat an average of 0.158 million gallons of sewage per day.
- The Bonneville Power Administration supplies power; average loads are 59.36 megawatts.

- Transportation in the region consists of local access roads, such as State Routes 240 and 24 and Interstates 82 and 90. Rail lines, including the onsite U.S. Government railroad, also serve the region.

Cultural Resources

- Native American settlement of the region began approximately 10,000 years ago. Europeans occupied the region during the 19th century.
- The Hanford Site contains numerous recorded archaeological and may contain additional traditional cultural properties important to Native American groups.
- The Hanford Site contains several industrial and architectural properties, including the Hanford B Reactor, that are listed on the National Register of Historic Places.

4.4.5 Idaho National Engineering Laboratory—Idaho Falls, Idaho

The Idaho National Engineering Laboratory (INEL) occupies 890 square miles (569,600 acres) of desert in the southeastern portion of Idaho, approximately 42 miles west of Idaho Falls. INEL was established in 1949 as a site where DOE could safely build, test, and operate various types of nuclear facilities. Currently, the focus of INEL is environmental restoration, waste management, and technology development. INEL is shown in Figure 4.4–5.

Included within the boundaries of INEL are two sites, Naval Reactors Facility (NRF) and Argonne National Laboratory-West (ANL-W), that are included in the analysis of the LLMW alternatives. The NRF site occupies 4,400 acres in the central portion of the INEL site, but only 84 acres are developed. The NRF is engaged in research and development for design and operation of naval nuclear propulsion plants as part of the joint DOE and Department of Navy Naval Nuclear Propulsion Program.

ANL-W is located on a 1,900-acre site on the southeastern portion of INEL. The primary mission of ANL-W is research and development in support of the Nation's fast reactor program. Approximately 850 persons are employed at ANL-W.

These two sites share the same environmental features with the INEL site and thus the summary descriptions presented below also apply to NRF and ANL-W.

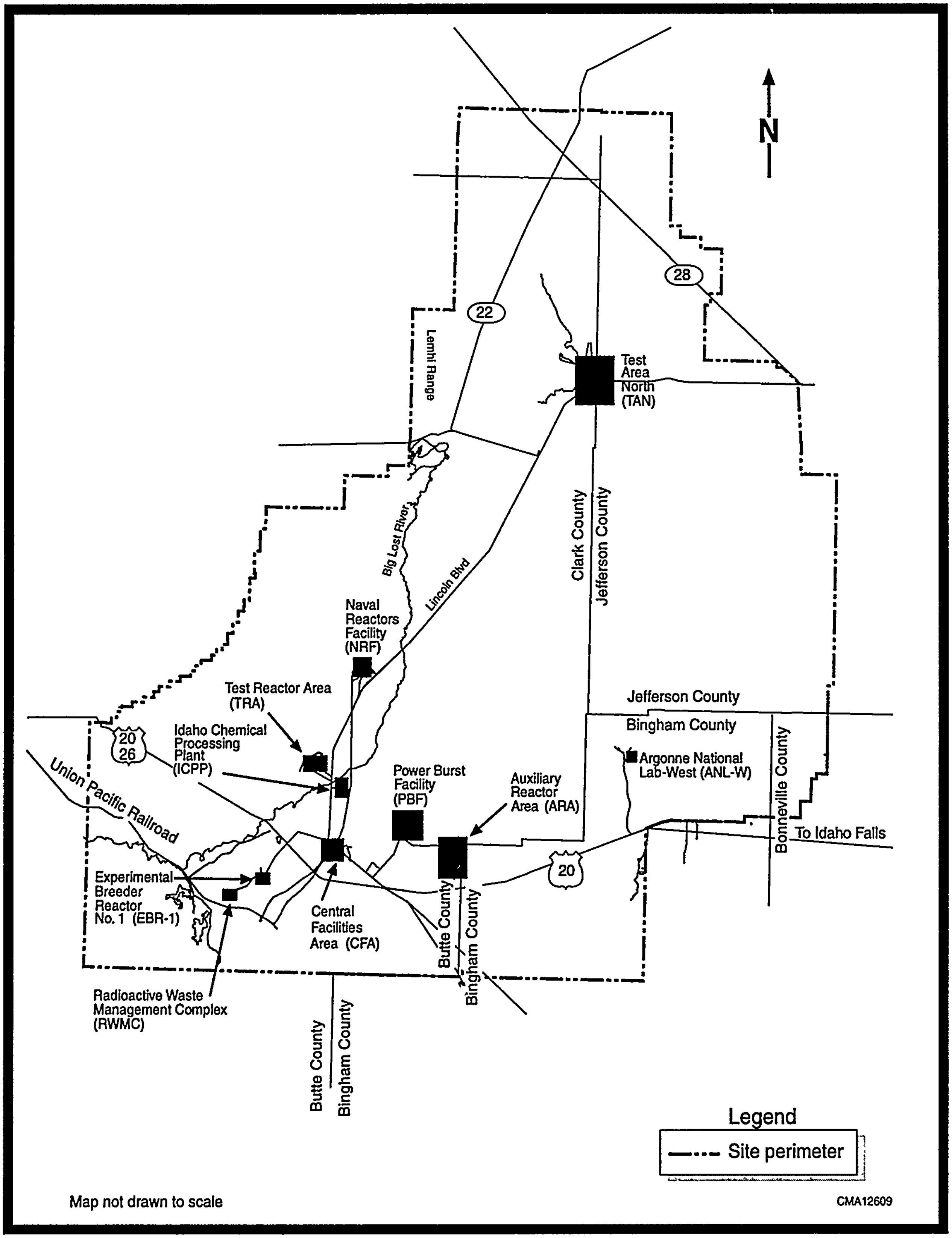

Figure 4.4–5. Idaho National Engineering Laboratory

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 153,061 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0015 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.030 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- The counties of Butte, Jefferson, Bonneville, and Bingham are classified as attainment areas for all six of the National Ambient Air Quality Standards criteria air pollutants.
- Major sources of air pollution at the site are the DOE programs, including irradiation services, calcination of liquid radioactive waste solutions, light-water-cooled reactor testing research, operation of research reactors, environmental restoration at the site, and storage and surveillance of solid transuranic waste.
- The prevailing wind directions are from the south to southwest and from northwest to northeast, with annual average speeds of 7 mph. Windspeeds are lowest during the winter months, averaging 5 mph, and highest during the spring months, averaging 8 mph. Annual temperatures average 42°F, ranging from -49 to 103°F.

Water Resources

- Major surface water features include the Big Lost River, the Little Lost River, and Birch Creek, all of which flow toward the INEL site, although only the Big Lost River actually flows onto the site in years of high precipitation. Because of infiltration, evaporation, and uptake by plants, none of the rivers flow off site.
- No Federally designated Wild and Scenic Rivers exist in the ROI.
- If Mackay Dam fails, the Idaho Chemical Processing Plant, the Naval Reactors Facility, and Test Area North would be flooded.
- Wastewater is discharged to onsite drainfields or evaporation/percolation ponds.
- Because creeks and rivers at INEL are ephemeral, surface water sampling can only be performed infrequently, after heavy precipitation events.
- Water is supplied by wells in the Snake River Plain Aquifer.

- The major groundwater unit is the Snake River Plain Aquifer, consisting of 1,000 to 2,000 feet of basaltic rocks and interbedded sedimentary sequences. It is considered a sole source aquifer.
- Groundwater monitoring for radioactive and nonradioactive parameters in 1992 showed levels above comparison criteria for four contaminants at onsite wells. No contaminants were found to exceed established EPA levels in offsite wells.
- Only one contaminant exceeded its comparison criterion in onsite wells in 1994.

Geology and Soils

- The topography is flat to gently rolling with frequent lava outcrops and an average elevation of 4,900 feet above sea level.
- The site is located in the Eastern Snake River Plain with the Lemhi, Lost River, and Bitterroot Mountain ranges bordering the site on the north and northwest.
- Underlying rock includes basaltic lava flows interbedded with sediments to a depth of several thousand feet.
- Soils beneath the southern part of the site are gravelly to rocky and generally shallow; the northern part is covered by lake and wind deposits, and most soils are composed of unconsolidated clay, silt, and sand.
- Geologic hazards include possible earthquakes with moderate to major probability of seismic damage. Historically, few earthquakes have occurred on the Eastern Snake River Plain, although two major earthquakes (Richter magnitude 7.5 and 7.3) have occurred within 100 miles of the site during the last 35 years. The most recent volcanism occurred about 2,100 years ago, 15 miles southeast of the site.

Ecological Resources

- Saltbrush deserts, juniper woodlands, native grasslands, big and low sagebrush, and riparian communities are found on INEL. Big sagebrush is dominant, covering approximately 80% of INEL. Nonnative cheatgrass is a serious threat to the integrity of the sagebrush shrub-steppe community. Unusual lava-tube cave systems are found throughout INEL and in nearby areas.
- Potential wetlands total approximately 2,000 acres and include waste ponds, river diversion spreading areas and hundreds of small playas.
- The bald eagle (Federal threatened, State endangered) and American peregrine falcon (Federal and state endangered) are found on INEL, but they do not reside year-round on INEL. No known critical habitat is found at INEL, and no known listed Federal or State threatened or endangered plant species are found at the site. However, one plant is listed by the State as imperiled, and eight Federal candidate

species (two are State species of special concern) and five State species of special concern are found on INEL.

Socioeconomic Conditions

- The ROI for INEL comprises Bannock, Bingham, Bonneville, Butte, Clark, and Jefferson Counties. At least 95% of the site's employees reside in these counties.
- Total site employment in 1990 was 11,813. Total ROI employment by place of work in 1990 was 99,692.
- The ROI unemployment rate was 5.3% in 1991.
- The ROI per capita income in 1990 was $14,622.
- The total population in the ROI in 1990 was 196,039. Population demographics: Native Americans—2.5%; urban—56.3%.
- Housing: owner-occupied—72.1%; renter-occupied—27.9%.
- Sensitive populations: children (under 15 years old)—30%; women of child-bearing age (ages 15 to 44)—21.6%; adults over 65—9.7%.

Environmental Justice

- Minorities—Figure C.4–11a.
- Below poverty level—Figure C.4–28.
- Presence of Federally recognized Native American Tribes: Fort Hall Shoshone-Bannock Tribes. Tribal lands—Figure C.4–11b.

Land Use

- The site occupies approximately 890 square miles (569,600 acres) of desert, of which 11,391 acres (2%) are developed, and the remainder is undeveloped; of the 550,000 acres that are undeveloped, approximately 330,000 acres are currently used for controlled grazing by cattle and sheep. The available area for future site development is approximately 22,330 acres.
- Land use surrounding the site is predominantly vacant and undeveloped, primarily devoted to grazing by sheep and cattle.

Infrastructure

- Onsite wells and storage tanks provide an average of 5.242 million gallons of water per day.

- Onsite treatment facilities (such as septic tanks, drainfields, or wastewater treatment plants) treat an average of 0.254 million gallons of sewage per day.
- The Idaho Power Company supplies power; the current load is 41.8 megawatts.
- Transportation in the region consists of local access roads such as U.S. Routes 20 and 26. Interstate 15 passes to the east of the site and intersects Interstate 84 to the south. Rail lines, including an onsite spur connecting to the Union Pacific Railroad, also serve the region.

Cultural Resources

- With only 5% of the facility surveyed, INEL contains at least 1,700 archaeological properties. The extent of INEL's architectural resources and traditional cultural properties has not been identified.
- INEL contains one National Historic Landmark—the Experimental Breeder Reactor #1. One archaeological site has been listed, and the Experimental Breeder Reactor #1 has also been designated for listing on the National Register of Historic Places.

4.4.6 Lawrence Livermore National Laboratory—Livermore, California

The Lawrence Livermore National Laboratory (LLNL) includes the Livermore Site, and LLNL Site 300. The WM PEIS also analyzed the Sandia National Laboratories (California) (SNL-CA) as part of LLNL. The LLNL Livermore Site occupies 1.3 square miles, is located 40 miles east of San Francisco and 3 miles east of Livermore in Alameda County, and employs 8,964 people. LLNL Site 300 covers 10.8 square miles, is located 15 miles southeast of Livermore, and employs 200 people. The SNL-CA is located on 413 acres next to and south of the LLNL Livermore Site. LLNL is shown in Figure 4.4–6.

In 1952, the Atomic Energy Commission (AEC) established the University of California Radiation Laboratory-Livermore Site (LLNL's predecessor) as a laboratory dedicated to nuclear weapons research. The University of California has managed and operated LLNL for DOE and its predecessor agencies. In 1953, to support the LLNL Livermore activities, the AEC purchased the first 4,000 acres of Site 300 for high-explosive testing. In 1956, SNL established the Livermore facility to provide a closer relationship with the LLNL design work. Today, the major programs at LLNL include defense and related programs, laser fusion, laser isotope separation, biomedical and environmental research, and environmental restoration and waste management.

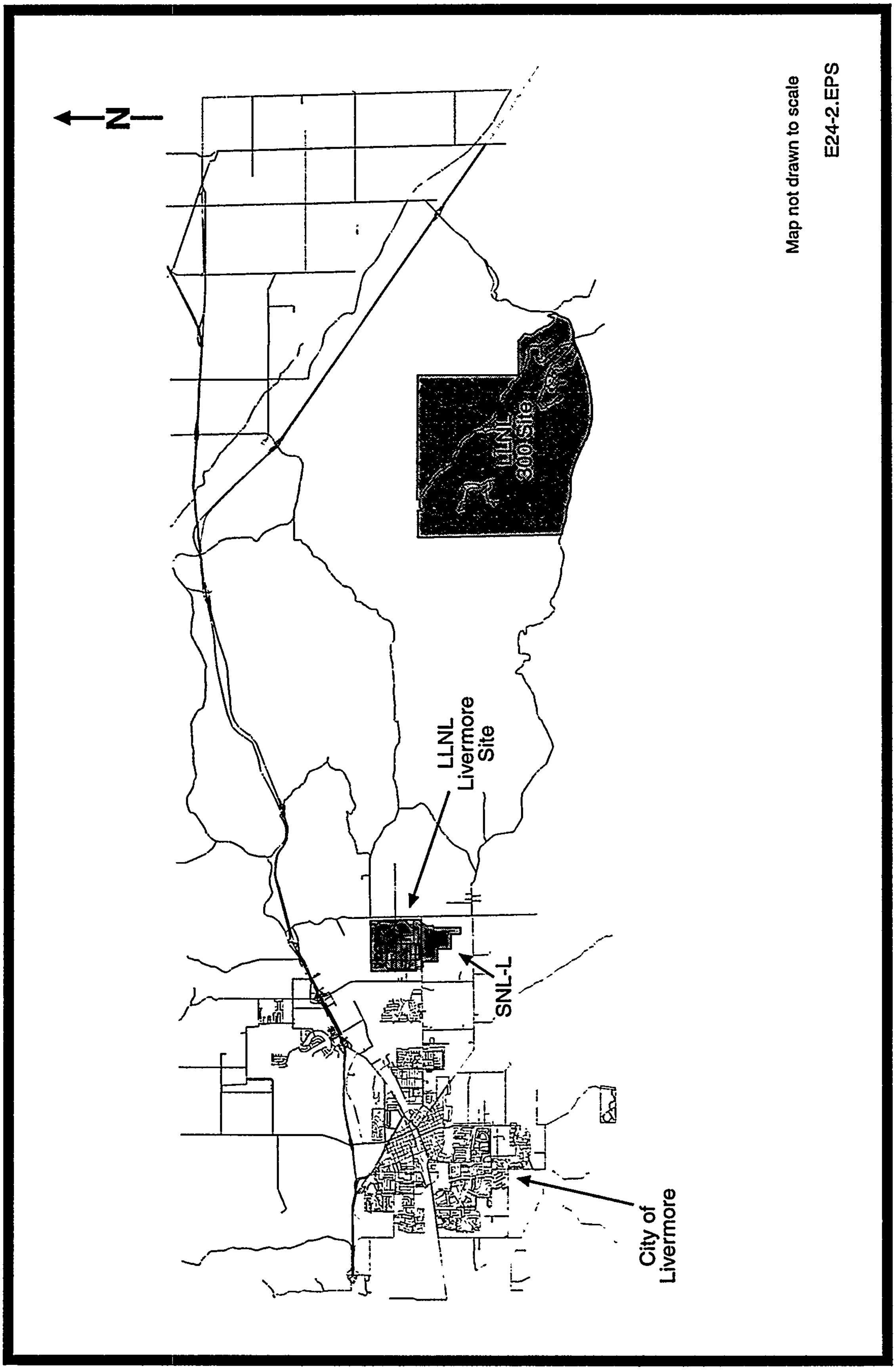

Figure 4.4–6. Lawrence Livermore National Laboratory

Owing to the proximity of SNL-CA to LLNL, the summary descriptions of environmental features presented below largely reflect the situations at SNL-CA.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 6,324,234 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) from point sources was 0.690 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a). The radiation dose from all sources for CY 1992 was 0.079 rem.
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 1.70 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Alameda County, which is located in the Bay Area Air Quality Management District, is currently classified as an attainment area for all six criteria air pollutants.
- Major sources of criteria pollutant emissions from the site are 96 boilers, 51 solvent cleaners, printing operations, paint booths, and oil shale experimental equipment. Tritium has been discharged from the tritium facility and miscellaneous diffuse sources.
- Prevailing winds at the San Francisco Airport in 1992 were from the west and northwest approximately 49% of the time, with the highest annual occurrence of windspeed of 4.6 to 11.5 mph 28% of the time. The average annual temperature is 59°F, ranging from a low monthly average of 46°F in January to a high monthly average of 71°F in July.

Water Resources

- Major surface water features at the Livermore Site include intermittent streams (such as Arroyo Mocho, Arroyo Seco, and Arroyo Las Positas), Patterson Reservoir (0.8 mile northeast of the Livermore Site), and Alameda Creek. Corral Hollow Creek is the only major surface water feature near Site 300 that receives drainage from local tributaries.
- No federally designated Wild and Scenic Rivers exist in the ROI.

- The Hetch Hetchy Aqueduct system supplies water for the Livermore Site. Groundwater is the main water supply for Site 300.
- No site facilities at either the Livermore Site or Site 300 lie within 100-year floodplains of Alameda Creek and Corral Hollow Creek, although portions of the Livermore Site adjacent to Greenville Road and portions of Site 300 near Corral Hollow Road are within the floodplains of the Arroyo Las Positas and Corral Hollow Creek, respectively.
- The majority of the wastewater generated from the Livermore Site discharges to the City of Livermore Water Reclamation Plant. Small amounts of low-threat wastewater are discharged into the stormwater drainage system under permits from the State and according to the CERCLA Record of Decision. Wastewater from Site 300 is released under permits, waivers, and agreements with the State of California.
- Major groundwater units at the Livermore Site include alluvial sediments and overlying lacustrine Livermore Formation sediments. Two water-bearing zones exist beneath Site 300 in the sandstones and conglomerates of the Neroly Formation. No aquifers are considered sole-source aquifers.
- Routine groundwater and surface water monitoring are conducted at both the Livermore Site and Site 300. Results of this monitoring are reported annually in the LLNL Environmental Report. Routine groundwater monitoring in 1992 showed that four parameters exceeded comparison criteria at the Livermore Site, and four parameters exceeded comparison criteria at Site 300.

Geology and Soils

- The LLNL Livermore Site is on relatively flat foothills with low relief and elevations ranging from 571 to 676 feet above National Geodetic Vertical Datum. Site 300 is in the Altamont Hills and includes steep ridges and canyons. Elevations range from 500 to 1,722 feet.
- The sediments beneath the Livermore Valley consist largely of the Livermore Formation. This includes gravel, sand, silt, and clay. Older formations are exposed at Site 300, which include the Panoche Formation, the Cierbo Formation sandstones, and the Neroly Formation.
- The soils at the Livermore Site are moderately developed soils and include loams, silty clay loams, gravelly loams, and clay loams. At Site 300, the soils are young with little or no development of the horizons that make up mature soils.
- Major faults in the area are the San Andreas, Hayward, Calaveras, and Greenville faults. Local faults have the greatest potential for damaging earthquakes.
- Local faults are the main seismic hazard with potential for damaging earthquakes.

- Potential for volcanic activity is small. Potential for slope instability at the Livermore site is also small. However, at Site 300, the potential for slope instability is considered moderate to high.

Ecological Resources

- At the Livermore Site, developed areas consist of ornamental vegetation and lawns; the undeveloped security zone is dominated by nonnative grasses. Wooded riparian habitat occurs along an arroyo.
- At Site 300, vegetation consists of the dominant introduced grassland (5,650 acres), native grassland, coastal sage scrub, oak woodland, and vegetation associated with seeps and springs. Site 300 includes a large stand of native perennial grassland now rare in California. Unique habitats include rocky outcrops and cliffs, two vernal pools, and forb communities along gullies.
- At the LLNL Livermore Site, wetlands occur along an arroyo and total 0.36 acres.
- At Site 300, wetlands total approximately 6.76 acres.
- At the LLNL Livermore Site, no threatened or endangered plant or animal species, or critical habitat has been found. Potential exists for the bald eagle (Federal threatened, State endangered), the San Joaquin kit fox (Federal endangered, State threatened), and the California red-legged frog (Federal proposed endangered) to be found, as well as one additional Federal proposed endangered species, three Federal candidate species, 32 State species of special concern, and two State threatened species. Several Federal and State endangered plants are also identified within the region.
- The large-flowered fiddleneck (Federal and State endangered), which is considered one of the most endangered plant species in California and possibly the nation, is found at Site 300. The peregrine falcon (Federal and State endangered), the San Joaquin kit fox (Federal endangered, State threatened), the longhorn fairy shrimp (Federal endangered), the conservancy fairy shrimp (Federal endangered), and the valley elderberry longhorn beetle (Federal threatened, State species of special concern) have been identified. Four State endangered, three State threatened, and 33 State species of special concern may occur at Site 300.

Socioeconomic Conditions

- The ROI for LLNL includes Alameda, Contra Costa, San Joaquin, and Stanislaus Counties. At least 97% of the Site's employees reside in these counties.
- Total site employment in 1994 was 8,713. Total ROI employment by place of work in 1990 was 1,512,433.
- The ROI unemployment rate was 9.3% in 1991.
- The ROI per capita income in 1990 was $21,099.

- The total population in the ROI in 1990 was 2,934,064. Population demographics: Native Americans—0.8%; urban—95.2%.
- Housing: owner-occupied—58.8%; renter-occupied—41.2%.
- Sensitive populations: children (under 15 years old)—22.2%; women of child-bearing age (ages 15 to 44)—24.2%; adults over 65—10.8%.

Environmental Justice

- Minorities—Figure C.4–12.
- Below poverty level—Figure C.4–29.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- LLNL includes the Livermore Site, which occupies 1.3 square miles (832 acres); LLNL Site 300, which is located 15 miles from the Livermore Sites and covers 10.8 square miles (6,927 acres); and SNL-CA, which is located on 413 acres next to the Livermore Site.
- LLNL, including the three sites, occupies a total area of 8,172 acres of which 323 acres are developed and 7,849 acres are undeveloped.
- Land use surrounding the Livermore Site and SNL-CA is predominantly agricultural, residential, and light industrial.
- Land use surrounding the LLNL Site 300 is predominantly agricultural, primarily for grazing cattle and sheep; however, the City of Tracy has plans for its development within approximately 1 to 1½ miles of Site 300's eastern boundary in its 1993 Urban Management Plan.

Infrastructure

- San Francisco's Hetch Hetchy water system provides an average of 0.717 million gallons of water per day.
- The city of Livermore's wastewater treatment system receives an average of 0.4 million gallons of sewage per day.
- The Pacific Gas and Electric Company and the Western Area Power Administration supply power; the current site load is 61 megawatts. The Pacific Gas and Electric Company also supplies natural gas.
- Transportation in the region consists of local access roads (such as South Vasco and Greenville Roads) and interstates (such as Interstates 580, 5, and 680). The Southern Pacific Railroad and the Western Pacific Railroad are the primary providers of rail service to the LLNL region.

Cultural Resources

- Native American occupation of the LLNL region began around 10,000 years ago, although no sites have been identified on the Livermore Site.
- LLNL Site 300 contains a variety of recorded archaeological properties, many of which have not been evaluated for the National Register of Historic Places. No traditional cultural properties or architectural resources have been recorded.

4.4.7 Los Alamos National Laboratory—Los Alamos, New Mexico

Los Alamos National Laboratory (LANL) occupies 43 square miles (27,520 acres) in north central New Mexico and is approximately 25 miles north of Santa Fe on Pajarito Plateau, a series of mesas separated by deep canyons. Since its inception in 1943, LANL's primary mission has been nuclear weapons research and development and related projects. LANL is shown in Figure 4.4–7.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 159,152 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 7.90 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 1.40 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- The area encompassed by, and the counties surrounding, LANL are classified by EPA as attainment areas for all six of the National Ambient Air Quality Standards criteria air pollutants.
- Major sources of criteria air pollutants are steam plants and power plants, operations associated with beryllium, an asphalt plant, burning of wastes at the area TA-16 burnground, experimental detonation of conventional explosives, and the lead-pouring facility.

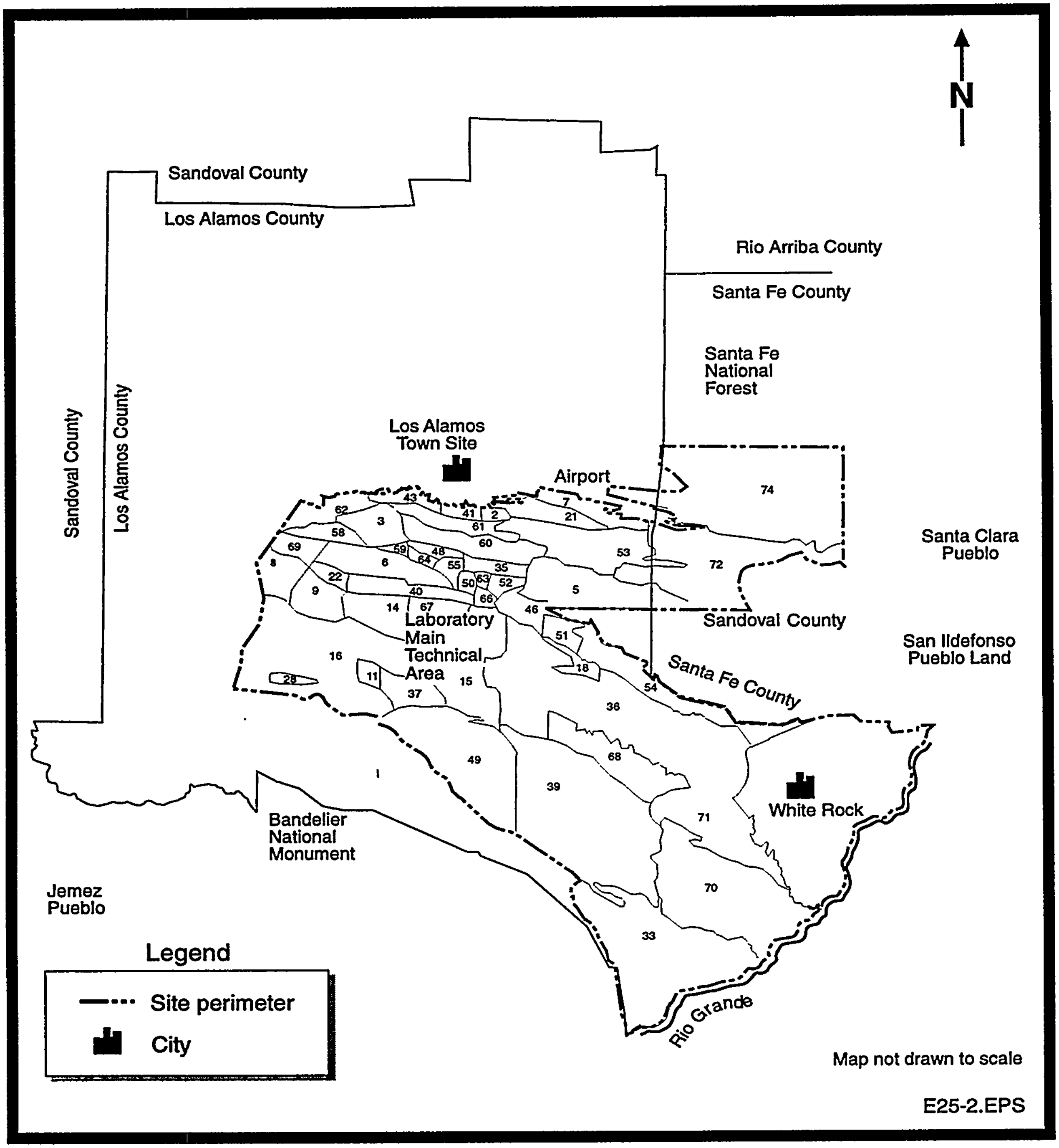

Figure 4.4–7. Los Alamos National Laboratory

- Prevailing winds at Albuquerque Airport for the 5-year period 1988-1992 were from the north approximately 10% of the time, with the highest annual occurrence of windspeed of 5 to 7 mph 38% of the time. The average annual temperature is 48°F, ranging from an average summertime daily maximum of 68°F to an average minimum in January of 29°F.

Water Resources

- Major surface water features include the Rio Grande (adjacent to the southeastern boundary of the site), 14 onsite intermittent tributaries, Rio de los Frijoles (parallels the southwestern boundary of the site), and the Los Alamos and Guaje Reservoirs.
- The East Fork of the Jemez River (located 5 miles west of LANL in a different drainage basin) is a federally designated Wild and Scenic River.
- Treated wastewater is discharged to onsite canyons. This water infiltrates into the ground and rarely reaches offsite areas.
- Surface water sampling in 1991 showed that 18 parameters exceeded their comparison criteria.
- Groundwater wells in the main aquifer supply water.
- Groundwater occurs within shallow alluvium, perched water, and in the main aquifer. The main aquifer is the only aquifer capable of supporting a municipal water supply and is hydrologically disconnected from the alluvial and perched waters. No aquifers are considered sole source aquifers.
- Groundwater monitoring in 1991 showed 13 parameters above comparison criteria.
- The technical areas located within the canyons would be within the 500-year floodplain of tributaries to the Rio Grande.

Geology and Soils

- The site is on the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep east-to-west oriented canyons cut by intermittent streams. Mesa tops range in elevation from about 7,800 to 6,200 feet.
- Major rock units include, from oldest to youngest, the Tesuque Formation sediments, the Chino Mesa Formation basalts, the Puye Formation conglomerates, the Tschicoma Formation volcanics, and the Bandelier Tuff (from a major volcanic eruption in the Jemez Mountains).
- Alluvium derived from erosion of the surrounding rocks fills many of the canyons, with thicknesses ranging from 3 to 100 feet.
- Soil types vary in texture from clay and clay loam to gravel. Rock is exposed on greater than 50% of the site area.

- Geologic concerns include potential downslope movements in association with regional seismic activity. The potential for subsidence is minimal, as is the potential for renewed volcanic activity.
- The strongest earthquake in the last 100 years within a 50-mile radius was estimated to have a magnitude of 5.5 to 6 on the Richter Scale. Studies have determined the presence of three active faults in the area.

Ecological Resources

- Major vegetative communities include juniper-grassland, piñon pine-juniper, ponderosa pine, mixed conifer, spruce-fir, and subalpine grassland. Old-growth forest may be present. LANL has minimized the clearing of vegetation, and canyons are relatively undisturbed. Specialized habitats include steep-walled cliffs and associated rockpiles and narrow mesas separated by deep canyons.
- Wetlands are restricted to several canyons and are primarily temporary or seasonal. Riparian habitat is receiving legal protection in some areas of the region.
- The bald eagle (Federal threatened, State endangered) and peregrine falcon (Federal and State endangered), one candidate species, one Federal notice of review species (State listed), and one State endangered species are found on LANL. Seventeen Federal- or State-listed species potentially are found nearby.

Socioeconomic Conditions

- The ROI for LANL comprises Los Alamos, Santa Fe, and Rio Arriba Counties. Ninety-four percent of the site's employees reside in these counties.
- Total site employment in 1994 was 6,199. Total ROI employment by place of work in 1994 was 83,496.
- The ROI unemployment rate in 1991 was 7.3%.
- The ROI per capita income in 1990 was $16,559.
- The total population in the ROI in 1990 was 151,408. Population demographics: Native Americans—5.4%; urban—64.2%.
- Housing: owner-occupied—71.1%; renter-occupied—28.9%.
- Sensitive populations: children (under 15 years old)—23.1%; women of child-bearing age (ages 15 to 44)—23.4%; adults over 65—9.9%.

Environmental Justice

- Minorities—Figure C.4–13a.

- Below poverty level—Figure C.4–30.
- Presence of Federally recognized Native American Tribes: Cochiti, Jemez, Nambe, Pojoaque, Santa Clara, San Ildefonso, San Juan, Picuris and Tesuque Pueblos.
  Tribal lands—Figure C.4–13b.

Land Use

- The site occupies approximately 43 square miles (27,520 acres), of which 11,333 acres are developed and 16,187 are undeveloped; of the land that is undeveloped, nearly all is available for future site development.
- LANL was designated a National Environmental Research Park in 1976.
- Land use surrounding the site is predominantly undeveloped with large tracts held by the Bureau of Land Management and the National Park Service.

Infrastructure

- Three DOE-operated well fields and surface water from the Jemez Mountains provide an average of 4.1 million gallons of water per day.
- An onsite wastewater treatment plant and collection system receives sewage.
- A Los Alamos County/DOE power pool and a 20-megawatt onsite gas fired generation plant supply power. In 1993, site usage was 68 megawatts.
- Transportation in the region consists of local access roads (such as U.S. Route 502) and other major roads (such as U.S. Routes 84 and 285 and Interstates 25 and 40). No major railroads provide rail service to the LANL region.

Cultural Resources

- Native American occupation of the LANL area began about 12,000 years ago.
- Over 975 prehistoric sites and 50 historic resources have been recorded. Approximately 75% of LANL has been inventoried for cultural resources.
- About 95% of the prehistoric and historic sites are considered eligible or potentially eligible for inclusion in the National Register of Historic Places.

4.4.8 Nevada Test Site—Las Vegas, Nevada

The Nevada Test Site (NTS) occupies 1,350 square miles (864,000 acres) of desert valley and Great Basin mountain terrain in southern Nevada, 65 miles northwest of Las Vegas. The NTS has been the primary location for testing the Nation's nuclear explosive devices since 1951. NTS is shown in Figure 4.4–8.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 14,266 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.012 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.0290 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Nye and Lincoln Counties are classified by EPA as attainment areas for all six National Ambient Air Quality Standards criteria air pollutants. Clark County is designated as a nonattainment area for the criteria air pollutants carbon monoxide and particulate matter of less than 10 micrometers in diameter (PM_{10}).

- Sources of radiological air emissions on the site are post-test drilling, mining, and sampling operations for underground nuclear tests and, possibly, evaporation of containment pond water. Other air pollutant emissions are from construction activities, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, fuels storage facilities, and asbestos removal activities.
- Prevailing winds at the McCarren International Airport in 1992 were from the southwest with a 12% occurrence. The highest annual occurrence of windspeed was between 4.6 and 11.5 mph, with an occurrence of 34%. Data from NTS towers indicate that prevailing winds are from the southwest during the summer and from the north to northwest during the winter. Temperatures range from an average daily minimum of 28°F in January to an average daily maximum of 96°F in July.

Water Resources

- The only permanent onsite water bodies are ponds associated with wastewater disposal and springs. No continuously flowing streams occur on the site.

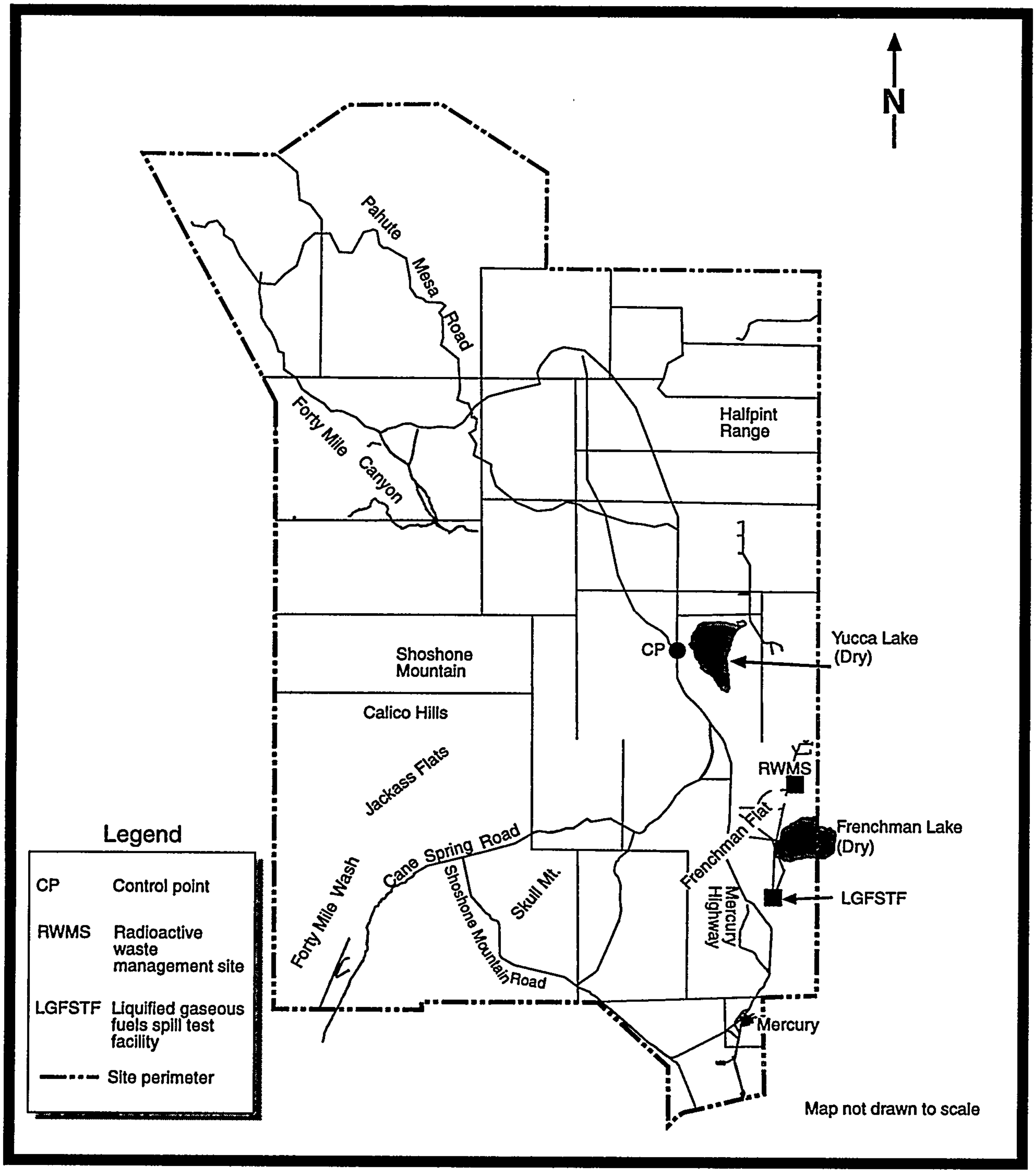

Figure 4.4–8. Nevada Test Site

- No federally designated Wild and Scenic Rivers exist on the site.
- During extreme precipitation, flash flooding may occur.
- Groundwater wells supply water.
- Onsite evaporation ponds receive waste discharge.
- Surface water sampling in 1991 showed nine parameters above comparison criteria.
- Major groundwater units include the lower carbonate aquifer, volcanic aquifer, and the valley fill aquifer. No aquifers are considered sole source aquifers.
- Groundwater monitoring in 1991 indicated that eight contaminant comparison criteria were exceeded at onsite wells.
- The site is not located within any floodplain as there are no continuously flowing surface water streams occurring on the site.

Geology and Soils

- The site is located in the Basin and Range physiographic province, with mountain ranges running from north to south separated by broad, flat-floored, and gently sloped valleys and elevations ranging from 3,000 to 6,900 feet.
- Major rock units include, from oldest to youngest, the Paleozoic carbonates and clastics, Tertiary tuffs and lavas, and Tertiary and Quaternary alluvium.
- Faults in the ROI include the Cane Springs and Yucca Faults.
- Severe earthquakes on faults in southern California (for example, the San Andreas Fault) should not result in damaging ground motion at the site. The Yucca Fault is the only capable fault on the NTS.
- Lava flows and associated cinder cones are within 30 miles of the site. The probability that a volcanic eruption would occur in the ROI in the near future is low.
- The potential for subsidence is low for a large portion of the site.

Ecological Resources

- Desert shrubs typical of the Mojave or Great Basin Deserts or transition desert between these two areas cover most of NTS. Shrubs and small trees are the dominant vegetation and vary, depending on elevation. Dominant associations include creosote bush, hopsage/desert thorn, sagebrush, and pinon pine and juniper with sagebrush. Crater environments and volcanic highlands are unique habitats.
- Springs and ponds have associated riparian areas, but no officially designated wetlands.
- The Federal and State endangered American peregrine falcon and Federal threatened and State protected desert tortoise are found on NTS. Nineteen candidate species are found on NTS (seven are State protected, one is State critically endangered, and one is protected as a game species); most

nonrodent species of mammals at NTS are on Nevada's protected species list. Twenty-one species of plants at NTS are State-listed. No plant species are federally endangered. Federal endangered aquatic species are located nearby at Ash Meadows (including the Devil's Hole pupfish, Warm Springs pupfish, Pahrump killifish, Ash Meadows speckled dace, and Ash Meadows Amargosa pupfish).

Socioeconomic Conditions

- The ROI for NTS comprises Nye and Clark Counties. One hundred percent of the site's employees reside in these counties.
- Total site employment in 1994 was 7,086. Total ROI employment in 1990 was 454,030.
- The ROI unemployment rate in 1991 was 5.4%.
- The ROI per capita income for 1991 was $18,543.
- The total population in the ROI in 1994 was 759,240. Population demographics: Native Americans—0.9%; urban—96%.
- Housing: owner-occupied—52.3%; renter-occupied—47.7%.
- Sensitive populations: children (under 15 years old)—21%; women of child-bearing age (ages 15 to 44)—23.2%; adults over 65—10.5%.

Environmental Justice

- Minorities—Figure C.4–14.
- Below poverty level—Figure C.4–31.
- Presence of Federally recognized Native American Tribes: Although none is located in the ROI, several have expressed an interest in DOE's waste management strategy. Interested tribal organizations include the Benton Paiute Reservation, Timbasha Shoshone Reservation, Bishop Paiute Reservation, Big Pine Point Shoshone Reservation, Fort Independence Reservation, Lone Pine Paiute Reservation, Yomba Reservation, Duckwater Reservation, Pahrump Paiute Tribe, Las Vegas Paiute Indian Colony, Chemehucvi Reservation, Colorado River Reservation, Paiute Indian Tribe of Utah, and Kaibab Paiute Reservation.

Land Use

- The site occupies approximately 1,350 square miles (864,000 acres) of desert valley and Great Basin mountain terrain, of which 25% is currently unused or provides buffer zones. Facility expansion is possible within all of the area in use.
- Land surrounding the site is predominantly federally owned.

Infrastructure

- Fourteen wells throughout the site supply an average of 1.36 million gallons of water per day.
- Onsite sewage treatment plants and septic tanks receive an average of 0.140 million gallons of sewage per day.
- The Nevada Power Company supplies power; the current site load is 30 megawatts.
- Transportation in the region consists of local access roads (such as Lathrop Wells Road, Jackass Flats Road, and Mercury Highway) and major routes (such as U.S. 95, U.S. 93, and Interstate 15). The Union Pacific Railroad is the primary provider of rail service to the NTS region.

Cultural Resources

- Human habitation of the NTS area dates from as early as 12,000 years ago. European contact began approximately 145 years ago.
- Numerous archaeological sites have been identified within the NTS facility. A long-range study will result in an 11% archaeological sample of NTS.

4.4.9 Oak Ridge Reservation—Oak Ridge, Tennessee

The Oak Ridge Reservation (ORR) occupies 35,000 acres in the valley and ridge province of eastern Tennessee. The ORR property was primarily used for agriculture before it was acquired by the Federal Government in 1942 for the wartime Manhattan Project. The ORR contains three major facilities: Oak Ridge National Laboratory (ORNL), the Y-12 Plant, and the K-25 Site. Also located on the ORR Site is the Oak Ridge Institute of Science and Education (ORISE), with an area of 340 acres. ORR is shown in Figure 4.4–9.

ORNL's mission is to conduct applied research and development in support of DOE programs in fusion, fission, conservation, and other energy technologies. The Y-12 Plant was established to separate uranium isotopes, and for many years served as a fabrication facility for nuclear weapons. The current Y-12 Plant mission is to perform defense-related assignments such as dismantling nuclear weapon components, providing special production support to various DOE programs, and serving as the nation's storehouse for special nuclear materials. The K-25 Site originally enriched uranium but was shut down permanently in 1987. Today, the K-25 Site's focus has shifted to supporting investigations related to waste management and environmental restoration issues and houses the Centers for Environmental Restoration and for Waste Management. The K-25 Site's evolving mission will include applied technology, data systems research and

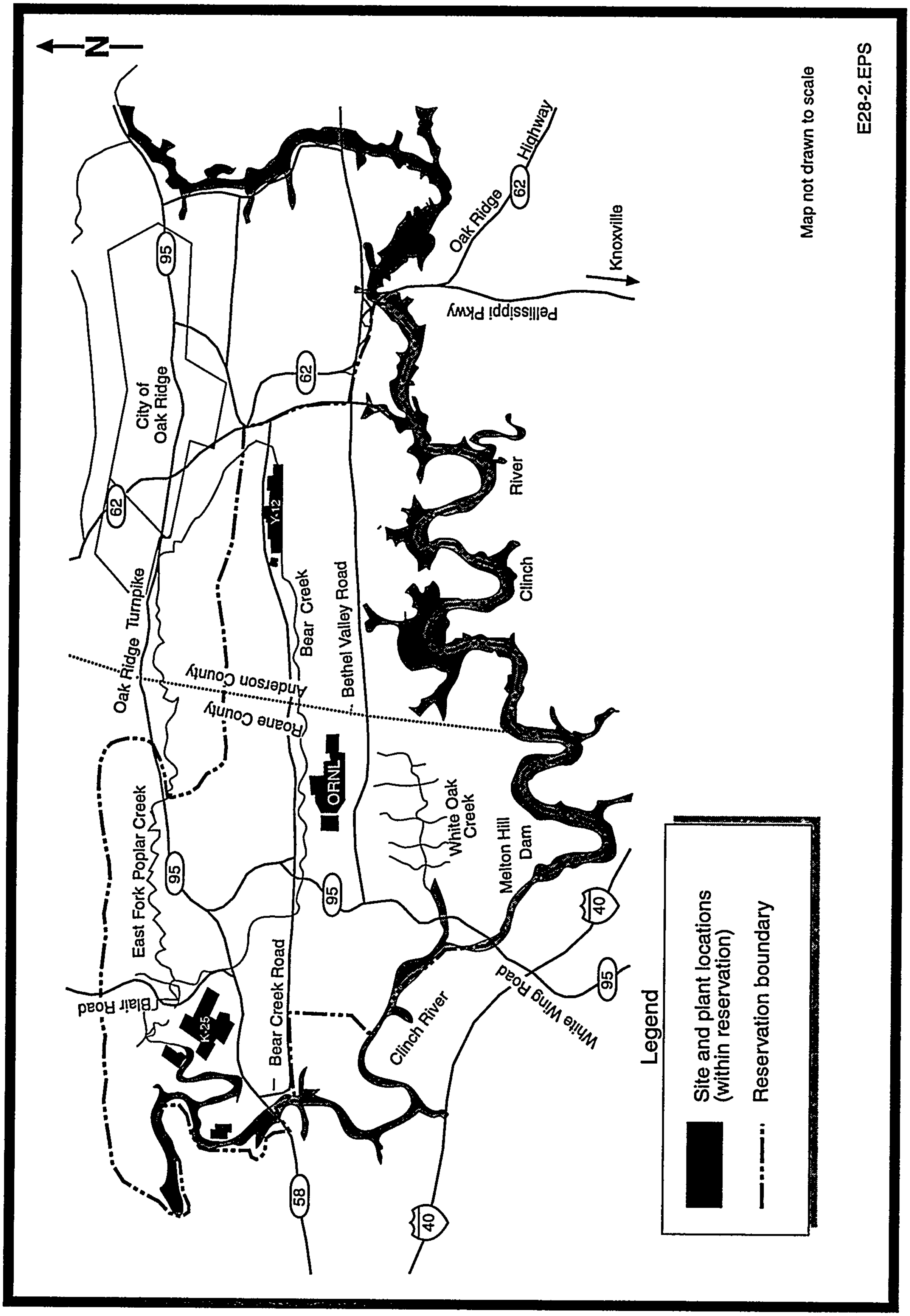

Figure 4.4-9. Oak Ridge Reservation

development, and engineering. ORISE works with DOE and others to provide capabilities in science and engineering education, particularly medical sciences, and environmental and energy systems.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 881,652 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 1.40 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 43 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- The Eastern Tennessee-Southwestern Virginia Interstate Air Quality Control Region is classified by EPA as an attainment area with respect to all six National Ambient Air Quality Standards criteria air pollutants.
- Major sources of criteria pollutant emissions from the site are steam plant emissions. The primary source of radionuclide emissions is the Toxic Substances Control Act Incinerator.
- Prevailing winds at ORR in 1992 were generally up-valley from the southwest and west-southwest or down-valley from the northeast and east-northeast; the highest occurrence of windspeed was between 1 and 4 mph with an annual occurrence of 58%. The average annual temperature is 57.3°F, ranging from an average daily minimum of 36.3°F in January to an average daily maximum of 87.2°F in July.

Water Resources

- Major surface water features include the Clinch River and its onsite tributaries—Bear Creek, East Fork Poplar Creek, White Oak Creek, Melton Branch, Poplar Creek, and Mitchell Branch.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- The Clinch River supplies water.
- Onsite streams and the Clinch River receive treated wastewater.
- Surface water sampling in 1992 showed concentrations of 26 parameters that exceeded comparison criteria.
- The major groundwater unit is the Knox Aquifer, composed of the Knox Group and the Maynardville Limestone. No aquifers are considered sole source aquifers.

- Groundwater monitoring for radioactive and nonradioactive parameters in 1992 indicated that 17 contaminants exceeded comparison criteria.
- Most of the ORR site is outside the 500-year floodplain of Clinch River except for areas adjacent to the confluences of White Oak Creek and Raccoon Creek with Clinch River.

Geology and Soils

- The topography consists of alternating valleys and ridges that strike northeast to southwest.
- Major rock units include, from oldest to youngest, the Rome Formation (sandstones and shales), the Conasauga Group (limestones and shales), the Knox Group (cherty limestones and dolomites), and the Chickamauga Group (limestones with interbedded shales).
- Unconsolidated residual material is 16 to 98 feet thick.
- The formation of karst solution pits and sinkholes has occurred in the carbonate bedrock. Changes to local groundwater levels or to surface water drainage patterns could create localized subsidence.
- The typical residual soil in the area is a reddish-brown clay. Alluvium also occurs in floodplains along streambeds. Valley soils are a mixture of clays, silts, and weathered shale fragments.
- The structure of the Valley and Ridge province is characterized by major subparallel thrust faults. None of these faults is considered capable.
- Seismic activity in the southern Appalachian Mountains that has affected the site area has been recorded 45 times since 1800. The probability of future seismic damage is moderate.

Ecological Resources

- Natural plant communities or pine plantations cover most of ORR. Vegetation consists of pine and pine-hardwood; hemlock, white pine and hardwood; cedar, cedar pine, and cedar-hardwood; bottomland hardwood; upland hardwood; northern hardwood; and nonforest. Upland hardwoods dominate. Upland hardwood, cedar barrens, and old fields are ecologically significant resources. Unique habitats include river bluffs and slopes and spring-fed limestone quarries.
- Approximately 20% of ORR consists of wetlands; half are bottomland forested and half are pothole wetlands.
- The Federal threatened and State endangered bald eagle has been located on ORR. Eight candidate species (two are State endangered, three are State threatened, and two are State in need of management), two State endangered species, and four State threatened species are found on ORR. Federal- and State-listed species are also present near ORR.

Socioeconomic Conditions

- The ROI for ORR comprises Anderson, Knox, Loudon, and Roane Counties. Ninety percent of the site's employees reside in these counties.
- Total site employment in 1990 was 21,544. Total ROI employment by place of work in 1990 was 287,974.
- The ROI unemployment rate in 1991 was 5.9%.
- The ROI per capita income in 1990 was $16,821.
- The total population in the ROI in 1990 was 482,481. Population demographics: Native Americans—0.25%; urban—67.9%.
- Housing: owner-occupied—68.3%; renter-occupied—31.7%.
- Sensitive populations: children (under 15 years old)—18.9%; women of child-bearing age (ages 15 to 44)—24.2%; adults over 65—13.3%.

Environmental Justice

- Minorities—Figure C.4–15.
- Below poverty level—Figure C.4–32.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site occupies approximately 35,000 acres of which 11,500 acres are developed and 23,500 acres are undeveloped; of the land that is undeveloped, approximately 5,629 acres are available for future site development.
- With the exception of the city of Oak Ridge to the north, land surrounding the site is predominantly rural, consisting of undeveloped forest land, agriculture, and low-density residential.

Infrastructure

- The Clinch River provides an average of 18.3 million gallons of water per day.
- The ORR wastewater facility serving K-25 and ORNL receives an average of 0.64 million gallons of sewage per day. Wastewater from the Y-12 facility is processed by the city of Oak Ridge.
- The Tennessee Valley Authority (TVA) supplies power; the current site load is 116 megawatts. Coal and natural gas are also used.
- Transportation in the region consists of local access roads (such as State Routes 1700 and 62) and major roads (such as Interstates 75, 40, and 81). The Southern Railway and the L&N Railway are the

primary providers of rail service to the ORR region, which includes a L&N rail line that runs adjacent to the site boundary.

Cultural Resources

- Native American occupation of the Oak Ridge area began about 12,000 years ago. European settlement began during the 18th century.
- More than 65 prehistoric sites and more than 240 historic resources (remains and standing structures) have been recorded at ORR. About 90% of the site has received at least reconnaissance-level studies; less than 5% has been intensely surveyed.
- About 10 prehistoric sites and 20 historic sites are potentially eligible for the National Register of Historic Places. The ORR Graphite Reactor has been designated as a National Historic Landmark.

4.4.10 PADUCAH GASEOUS DIFFUSION PLANT—PADUCAH, KENTUCKY

Paducah Gaseous Diffusion Plant (PGDP) occupies 3,425 acres in western Kentucky 10 miles west of Paducah, and employs 1,868 people. Paducah has been an active uranium enrichment facility since 1952. Enriched uranium is produced for the commercial sector as fuel for nuclear power reactors in the United States and overseas. Paducah is shown in Figure 4.4–10.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 500,502 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0045 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.017 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- McCracken County is currently classified by EPA as a marginal nonattainment area for ozone. The area is in attainment for the other five criteria pollutants.

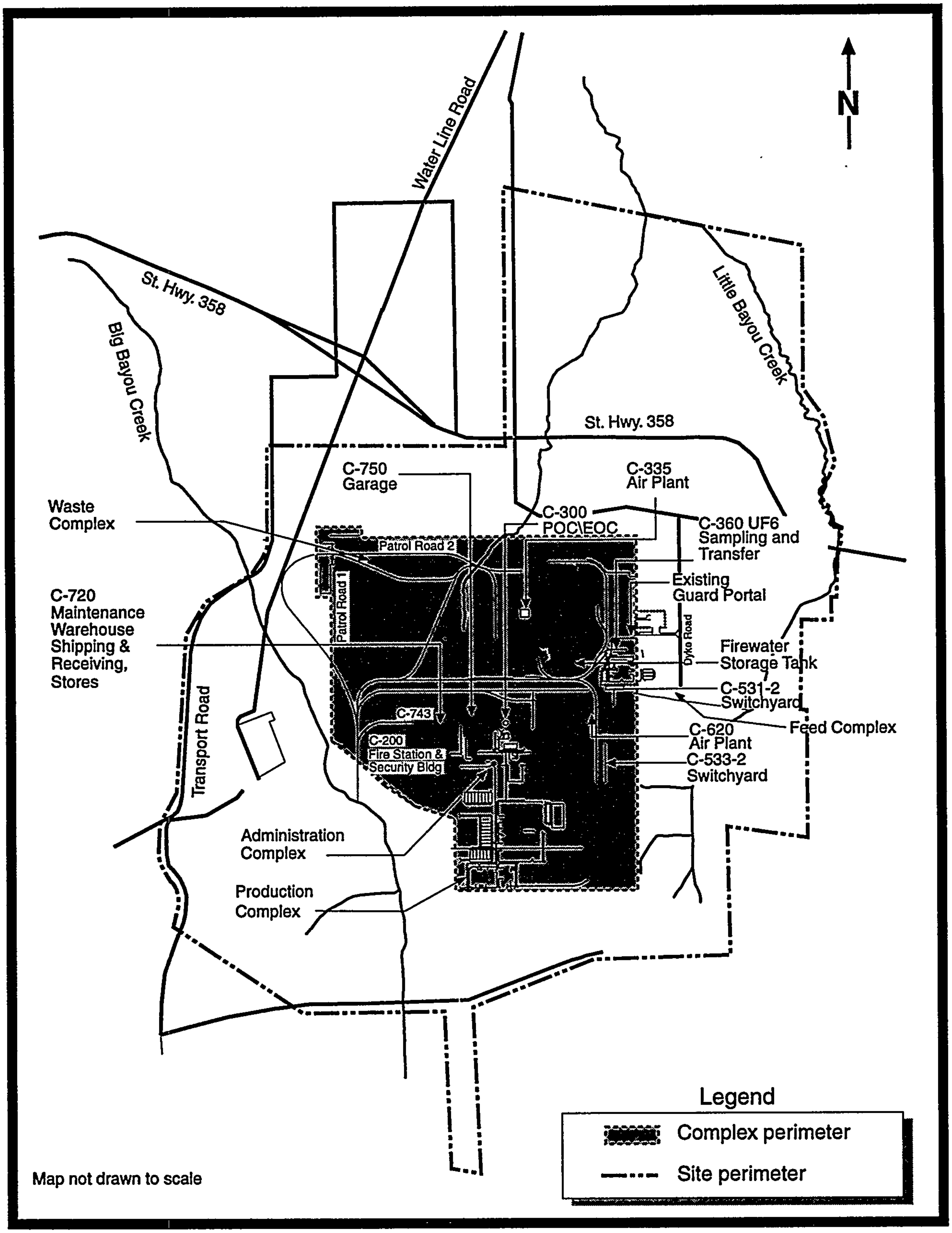

Figure 4.4–10. Paducah Gaseous Diffusion Plant

- The major sources of criteria air pollutant emissions are coal-, oil-, and gas-fired boilers. Sources of radionuclide emissions in 1992 were the cascade purge vent/stack at the C-310 purge and product building, decontamination activities at the C-400 cleaning building, and emissions from laboratory hoods in the C-710 building. Two vapor degreasers in the C-400 cleaning building are also sources of toxic air emissions.
- Prevailing winds at the Paducah Airport in 1992 were from the south 16% of the time on a yearly basis. The highest occurrence of windspeed was between 8 to 11 mph with an annual occurrence of 31%. January is the coldest month, with a daily average temperature of 35°F, while July is the warmest month with an average temperature of 79°F.

Water Resources

- Major surface water features include the Ohio River (less than 2 miles from Paducah), Metropolis Lake (1.5 miles northeast), and two small tributaries of the Ohio River (Big Bayou Creek and Little Bayou Creek) that provide surface drainage to the site.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- The site would not be affected by the probable 500-year maximum flood.
- The Ohio River supplies water to Paducah.
- Onsite streams and the Ohio River receive treated wastewater.
- Results from surface water monitoring in 1992 indicated concentrations elevated above comparison criteria for two contaminants.
- Major groundwater units include, from bottom to top, the McNairy Flow System (interbedded sand, silt, and clay), the terrace gravels, the Regional Gravel Aquifer (the primary aquifer in the area, composed of sand and gravel units), and the Upper Continental Recharge System (clayey silt with interbedded sand and gravel). No aquifers are considered sole source aquifers.
- Groundwater monitoring for radioactive and nonradioactive parameters in 1992 showed the presence of 15 contaminants exceeding comparison criteria. Two major plumes of groundwater contamination extend into offsite areas.
- The site is outside the 500-year floodplain of the Ohio River.

Geology and Soils

- The topography slopes slightly from more than 450 feet in the southern part of the site to 300 feet near the Ohio River.
- Surface sediments consist of valley fill deposits, which underlie most of the site, extending northward to the Ohio River.

- Major rock units include, from oldest to youngest, basement rocks; Tuscaloosa Formation basal gravels; the McNairy Formation consisting of interbedded sand, silt, and clay; the Porters Creek Clay; continental deposits of gravel and clay-sand units; and a 10-to-30-foot layer of loess (wind-blown sediment).
- Soils beneath the site are nearly level, somewhat poorly-drained, medium-textured soils that occur on uplands.
- Geologic hazards include potential for earthquakes. The site is near two active seismic zones: the New Madrid Fault Zone and the Wabash Valley Fault Zone. The potential for damage from volcanic activity is small.

Ecological Resources

- Nonforested areas consisting of mowed grass and developed areas cover most of Paducah; forested areas are small and dominated by mature hardwood upland and riparian forests.
- Onsite wetlands consist of forested wetlands (mature riparian hardwood forest). A wetland in the West Kentucky Wildlife Management area (the buffer area surrounding the production facilities) has been designated an area of ecological concern.
- Federally listed endangered and State-listed endangered species that have been identified or could be identified in the vicinity of Paducah include the interior least tern and four species of pearly mussel. The Indiana bat, a Federally and State-listed endangered species, also has been identified or could be identified in the vicinity of Paducah. An additional species of pearly mussel is Federally listed as endangered only. The bald eagle (Federally threatened, State endangered), evening bat (Federal threatened, State species of special concern), eight candidate species (one is a State-endangered fish, one is a State-threatened reptile, and one is a State species of special concern), one State-endangered bird species, two State-threatened plant species, and seven State species of special concern are found or could be found near Paducah. No Federally listed plant species potentially occur in the vicinity of Paducah.

Socioeconomic Conditions

- The ROI for Paducah comprises McCracken, Ballard, Carlisle, Graves, and Marshall Counties in Kentucky, and Massac County in Illinois. Ninety-three percent of the site's employees reside in these counties.
- Total site employment in 1990 was 1,740. Total ROI employment by place of work in 1990 was 79,756.

- The ROI unemployment rate in 1991 was 9.7%.
- The ROI per capita income in 1990 was $15,536.
- The total population in the ROI in 1990 was 151,526. Population demographics: Native Americans—0.2%; urban—44.1%.
- Housing: owner-occupied—55.6%; renter-occupied—44.4%.
- Sensitive populations: children (under 15 years old)—20.2%; women of child-bearing age (ages 15 to 44)—17.6%; adults over 65—16.8%.

Environmental Justice

- Minorities—Figure C.4–16.
- Below poverty level—Figure C.4–33.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site occupies approximately 3,425 acres, of which 750 acres are developed and 2,675 acres are undeveloped.
- Land use surrounding the site is predominantly undeveloped natural areas.

Infrastructure

- The Ohio River supplies an average of 15 million gallons of water per day; the water is treated onsite by chemical and physical processes.
- An onsite treatment plant receives an average of 0.2 to 0.4 million gallons of sewage per day. Treated sewage is discharged off site.
- Electric Energy Inc. supplies power; the current site load is 1,564 megawatts. The site also uses approximately 82 tons of coal per day.
- Transportation in the region consists of local access roads (such as State Routes 1154 and 358) and major roads (such as Interstate 24 and U.S. Highways 45, 60, and 63). The Burlington Northern Railroad, Paducah Railroad, Louisville Railroad, and the onsite U.S. Government Railroad are the primary providers of rail service to the Paducah region.

Cultural Resources

- The site has 3 recorded archaeological or historic sites, and others have been identified in areas near Paducah. This region has not been subject to any systematic cultural resources surveys.

4.4.11 Pantex Plant—Amarillo, Texas

The Pantex Plant is approximately 17 miles northeast of downtown Amarillo, Texas, on the Llano Estacado (Staked Plains) and consists of 10,080 acres of DOE-owned land and 5,856 acres of land leased from Texas Tech University. The Pantex Plant was first used in 1942 by the Army Ordnance Corps for loading conventional ammunition shells and bombs. It was chosen in 1951 by the Atomic Energy Commission for expansion of its nuclear weapons assembly facilities. The mission of the Pantex Plant includes disassembly, assembly, quality evaluation, and maintenance of the Nation's nuclear weapons stockpile. The workforce at the Pantex Plant currently consists of 77 DOE employees and 2,930 prime contractor employees. The Pantex Plant is shown in Figure 4.4–11.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 265,185 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was less than 0.0001 mrem per year according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was negligible according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Potter and Armstrong Counties are classified by EPA as attainment areas for all six of the criteria air pollutants.
- The major source of emissions from the Pantex Plant is the boiler house for the steam plant. Sources of volatile organic compound emissions include building 16-4 (paint spray booth), building 12-19 (HE formulation), and building 11-36 (HE synthesis).
- Prevailing winds at the Amarillo International Airport in 1992 were from the south 13.5% of the time on a yearly basis; the highest occurrence of windspeed was between 12.5 to 18.4 miles per hour with an annual occurrence of 35%.

Water Resources

- No streams or rivers flow through or near the Pantex Plant; the only natural onsite surface water bodies are numerous ephemeral playa basins.
- No federally designated Wild and Scenic Rivers exist in the ROI.

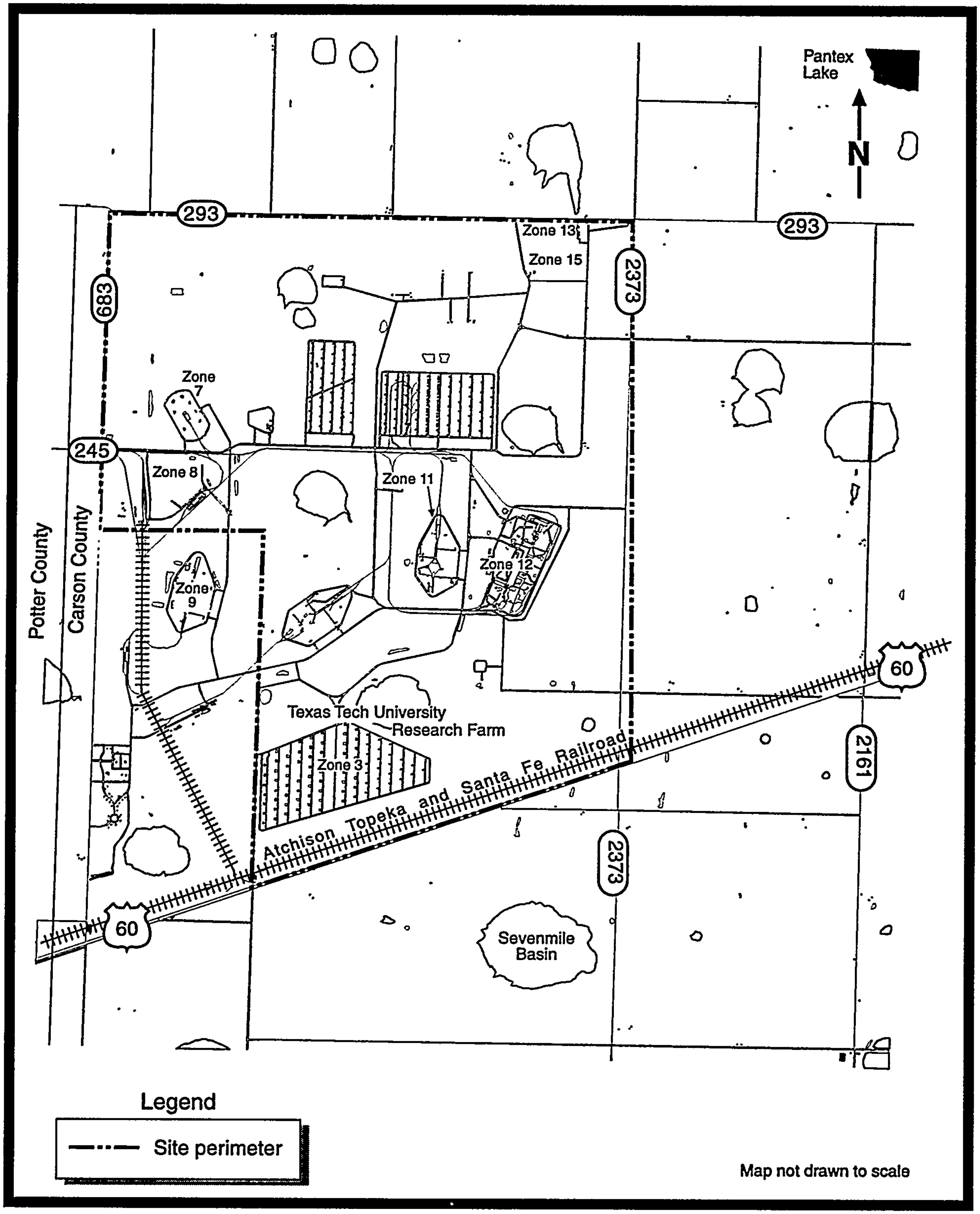

Figure 4.4–11. Pantex Plant

- Based on the results of a flood hazards analysis, the probability of flooding is low.
- Onsite playas receive treated wastewater.
- Onsite surface water sampling in 1992 showed concentrations of four parameters that exceeded comparison criteria. No offsite sampling was performed.
- Groundwater wells in the Ogallala Aquifer supply water.
- Major groundwater units include the Ogallala Aquifer, the primary source of water for the multi-billion-dollar agricultural industry in the Panhandle, and the underlying Dockum Group Aquifer. No aquifers are considered sole source aquifers.
- Groundwater monitoring in 1992 indicated that 10 parameters exceeded comparison criteria.
- The Pantex Plant is not located within a 500-year floodplain.

Geology and Soils

- The topography at the site is relatively flat and is characterized by rolling plains and numerous natural playa basins, or ephemeral lakes. Elevations range from approximately 3,500 to 3,600 feet above National Geodetic Vertical Datum.
- Major rock units include, from oldest to youngest, crystalline basement rocks, the Triassic Dockum Group (sedimentary rocks), the Ogallala Formation (sand, silt, clay, gravel, and some caliche), and the Blackwater Draw Formation (the surface deposit consisting of buried soils and silty clay and caliche).
- The primary soils at the site are deep clay loams and clays that occur on gentle slopes.
- No active surface faults occur in the ROI.
- Only 36 felt earthquakes have occurred in the Texas Panhandle between 1906 and 1986. Four earthquakes occurred near the site between 1982 and 1989. The potential for damage from earthquakes or volcanic activity is small.

Ecological Resources

- Very little relatively undisturbed habitat exists on the site. Vegetation consists of native and improved pasture, short-grass prairie, or planted vegetation.
- Wetlands are associated with five playas on the Pantex Plant; numerous smaller wetlands (10 acres or less) are on the western and southwestern parts of the site. The playas on the Pantex Plant constitute 376 acres.
- No critical habitat is known at the Pantex Plant. Federal and State endangered species found on or near the site include the American peregrine falcon, interior least tern, and whooping crane. The bald eagle

(Federal threatened and State endangered) is also found on or near the site. The Federal and State threatened Arctic peregrine falcon, the State-threatened white faced ibis and Texas horned lizard, and the State-endangered smooth green snake may also be found.

Socioeconomic Conditions

- The ROI for the Pantex Plant includes Carson, Potter, and Randall Counties. At least 96% of the site's employees reside in these counties.
- Total site employment in 1990 was 2,891. Total ROI employment by place of work in 1990 was 104,254.
- The ROI unemployment rate was 4.9% in 1991.
- The ROI per capita income in 1990 was $16,991.
- The total population in the ROI in 1990 was 194,123. Population demographics: Native Americans—0.7%; urban—87.2%.
- Housing: owner-occupied—64.7%; renter-occupied—35.3%.
- Sensitive populations: children (under 15 years old)— 24%; women of child-bearing age (ages 15 to 44)—23.2%; adults over 65—11.7%.

Environmental Justice

- Minorities—Figure C.4–17.
- Below poverty level—Figure C.4–34.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site consists of 10,080 acres of DOE-owned land and 5,856 acres of land leased from Texas Tech University for a total of 15,936 acres. Of the DOE-owned land, approximately 2,000 acres are developed and 8,080 acres are undeveloped; of the undeveloped land, approximately 7,713 acres are available for future site development.
- Land use surrounding the site is predominantly agricultural, involving both farming and ranching operations.

Infrastructure

- Five production wells in the Ogallala Aquifer provide an average of 0.5 million gallons of water per day.

- An onsite wastewater treatment plant and an open ditch that drains to an onsite playa receive an average of 0.275 million gallons of sewage per day.
- The Southwestern Public Service Company supplies power; the current site load is 12.6 megawatts.
- Transportation in the region consists of local access roads (such as State Routes 293, 245, and 683), and major roads (such as Interstates 40 and 27 and U.S. Highways 60 and 287). The Atchison, Topeka, and Santa Fe Railroads are the providers of rail service to the Pantex Plant region.

Cultural Resources

- The site has 42 prehistoric archaeological sites and 3 historic farmstead sites. The Texas State Historic Preservation Office has not evaluated whether the Pantex Plant may contain additional unrecorded archaeological sites.

4.4.12 Portsmouth Gaseous Diffusion Plant—Portsmouth, Ohio

The Portsmouth Gaseous Diffusion Plant (PORTS) is approximately 22 miles northeast of Portsmouth in Pike County, Ohio, occupying an area of 6.3 square miles (4,003 acres). Construction of the site began in late 1952 and ended in 1956, one year after the start of uranium enrichment processing at the site. Portsmouth was operated through November 1986 for DOE and its predecessor agencies by the Goodyear Atomic Corporation. Since then, Portsmouth has been managed by Martin Marietta Energy Systems, Inc. The mission of Portsmouth continues to be uranium enrichment. Portsmouth is shown in Figure 4.4–12.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 639,602 based on 1990 Census data (DOC, 1991, DOE 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.260 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 3.0 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Pike County is currently classified by EPA as an attainment area for all six National Ambient Air Quality Standards criteria air pollutants.

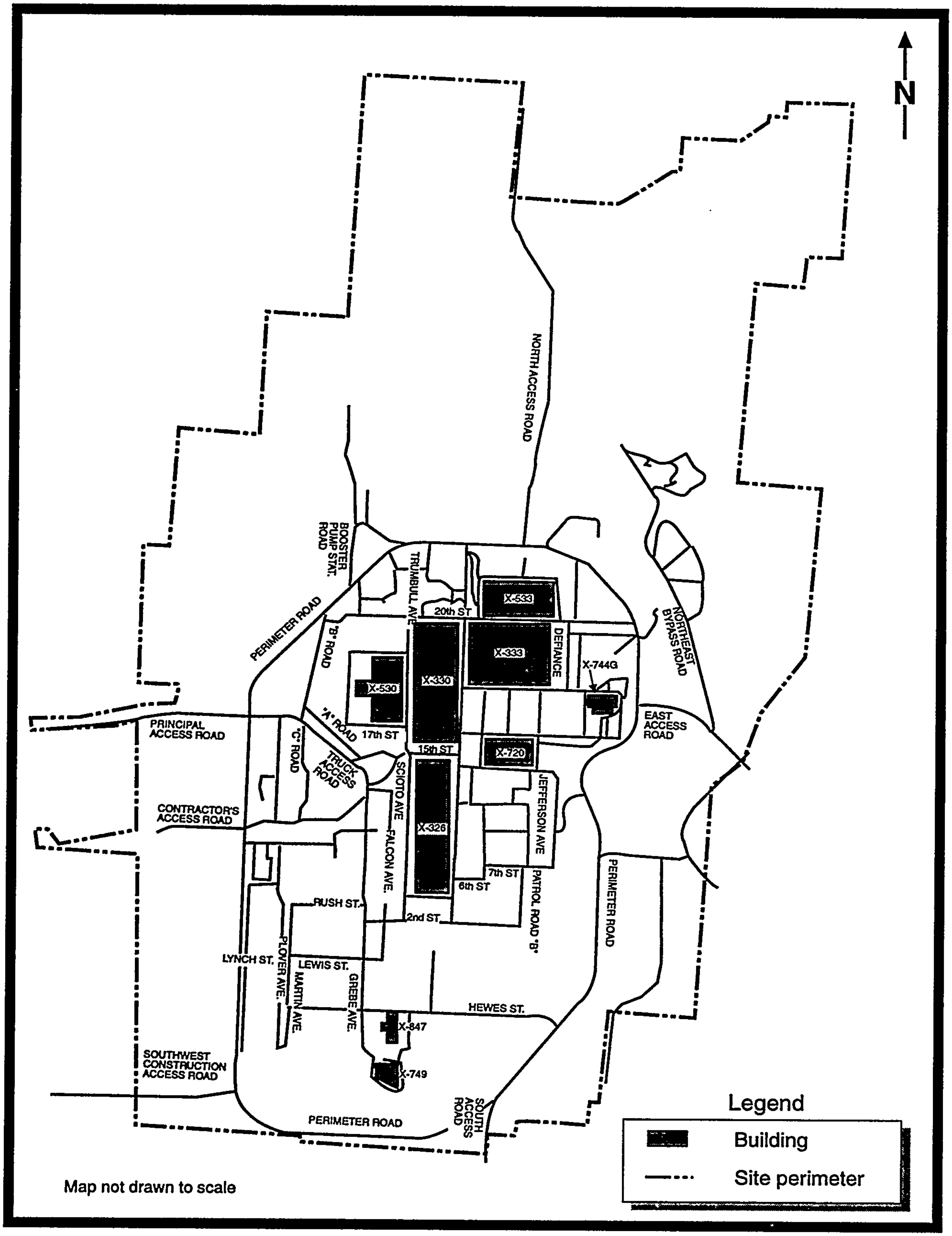

Figure 4.4-12. Portsmouth Gaseous Diffusion Plant

- The major sources of criteria pollutant emissions are three coal-fired boilers at the X-600 steam plant. Sources of radionuclide and fluoride emissions include purge cascade vents, cold recovery and wet evacuation vents, the X-345 high assay sampling area vent, the X-344 evacuation vent, and six seal exhaust vents.
- Prevailing winds at Portsmouth are from the south to southwest, with the south averaging the highest at just over 11%. Windspeeds average 5 mph, with winds up to 75 mph on record. The average annual temperature measured at Portsmouth during 1992 was 55°F, with seasonal average temperatures of 32°F or below in the winter, and 90°F or above in the summer.

Water Resources

- Major surface water features include the Scioto River and its onsite tributaries—Little Beaver Creek and Big Run Creek.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- An alluvial aquifer and the Scioto River supply water.
- Onsite streams and the Scioto River receive treated wastewater.
- Surface water sampling in 1992 showed four parameters above their comparison criteria.
- Major groundwater units include the Mississippian shale and sandstone bedrock aquifer and the unconsolidated sediment aquifer.
- Onsite groundwater monitoring in 1992 showed eight parameters above comparison criteria; no contaminants exceeded comparison criteria in measurements of offsite groundwater.
- The site is located outside a 500-year floodplain.

Geology and Soils

- The site is on gently rolling land about 130 feet above the Scioto River with an average elevation of 670 feet above National Geodetic Vertical Datum.
- The predominant landform in the area is a relatively level, filled valley of the preglacial Portsmouth River, which runs north to south.
- Major rock units include, from oldest to youngest, the Ohio Shale, the Bedford Shale, the Berea Sandstone, the Sunbury Shale, and the Cuyahoga Shale.
- The site is in an abandoned river valley filled with fluvial materials. These unconsolidated sediments are the Gallia Sand Member and the Minford Clay Member.
- The soils in the fenced area are mostly urban land and are covered by roads, parking lots, buildings, and railroads. Other soils are well-drained, upland soils.

- No significant geologic faults exist in the ROI.
- The potential for damage from volcanic activity is small.

Ecological Resources

- Vegetation consists of pastureland, old fields, oak-hickory, upland mixed hardwood, bottomland mixed hardwood, pine, second-growth hardwood, and scrub thicket. All forests and old fields are second growth.
- Wetlands at Portsmouth are minimal and total only one acre.
- The Federal and State endangered Indiana bat has been identified in the vicinity of Portsmouth. One candidate species (listed as State threatened), four State endangered species, five State threatened species, four State potentially threatened species, and seven State special interest species occur near Portsmouth. No threatened or endangered plants have been located on the site.

Socioeconomic Conditions

- The ROI for Portsmouth comprises Pike, Jackson, Ross, and Scioto Counties. Ninety-two percent of the site's employees reside in these counties.
- Total site employment in 1990 was 2,386. Total ROI employment by place of work in 1990 was 77,806.
- The ROI unemployment rate in 1991 was 9.3%.
- The ROI per capita income in 1990 was $19,918 (1990 dollars).
- The total population in the ROI in 1990 was 204,136. Population demographics: Native Americans—0.34%; urban—35.62%.
- Housing: owner-occupied—70%; renter-occupied—30%.
- Sensitive populations: children (under 15 years old)—21.9%; women of child-bearing age (ages 15 to 44)—21.3%; adults over 65—13.7%.

Environmental Justice

- Minorities—Figure C.4–18.
- Below poverty level—Figure C.4–35.
- Presence of Federally recognized Native American Tribes: none.

Land Use

- The site occupies approximately 6.3 square miles (4,003 acres), of which 800 acres are developed and 3,203 acres are undeveloped; of the land that is undeveloped, nearly all is available for future site development.
- Land use surrounding the site is predominantly rural.

Infrastructure

- An onsite facility and 31 offsite supply wells provide an average of 14 million gallons of water per day.
- An onsite facility receives an average of 0.35 million gallons of sewage per day.
- The Ohio Valley Electric Corporation supplies power via an electrical and coal-fired system; the current site load is 1,537 megawatts of electricity and 4,500 tons of coal per month.
- Transportation in the region consists of local access roads (such as Piketon Hill Road and State Route 32) and major roads (such as Interstate 70 and U.S. Highways 23, 52, and 50). The Chesapeake and Ohio Railroad and Norfolk and Western Railroad are the primary providers of rail service to the Portsmouth region.

Cultural Resources

- The site has no recorded archaeological sites, standing structures, or traditional cultural properties, except for two cemeteries in the northeast corner of Portsmouth. This property has not been subject to a comprehensive cultural resources survey.

4.4.13 Rocky Flats Environmental Technology Site—Golden, Colorado

The Rocky Flats Environmental Technology Site (RFETS) occupies 6,500 acres approximately 16 miles northwest of Denver, in Jefferson County, Colorado, and employs 7,365 employees. From 1952 to 1992, the primary mission of RFETS was producing nuclear weapons components. The mission has now changed to special nuclear material stabilization and storage, as well as decontamination and decommissioning and cleanup. RFETS is shown in Figure 4.4–13.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 2,171,877 based on 1990 Census data (DOC, 1991, 1992b,c).

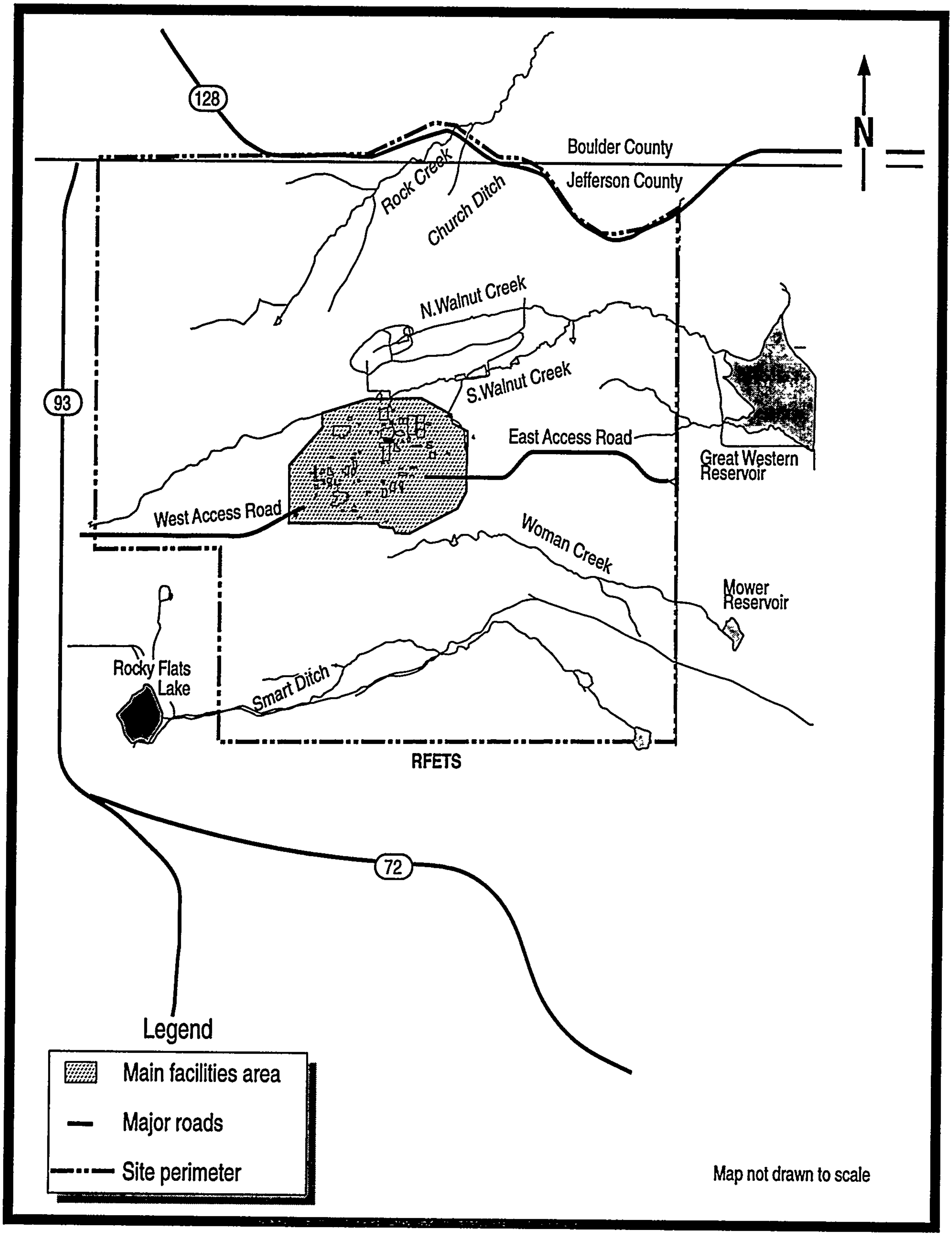

Figure 4.4–13. Rocky Flats Environmental Technology Site

- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0002 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.140 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Jefferson County is classified by EPA as a Federal nonattainment area for carbon monoxide, ozone, and particulate matter less than 10 micrometers in diameter (PM_{10}). The area is in attainment for the other three criteria air pollutants.
- The major sources of air pollution at the site are the emergency diesel generators and the natural-gas-powered boilers that produce steam for the site.
- Winds from the south were the most prevalent at Stapleton Airport in 1992 (14% of the time), and the most frequent windspeed was from 5 to 7 mph (45% annually). Mean windspeeds measured at RFETS in 1990 were 9.0 mph; highest was 88.6 mph. Mean temperature at RFETS in 1992 was 49.2°F, with temperatures ranging from a maximum monthly average in July of 77°F and a minimum monthly average in December of 17°F.

Water Resources

- Major surface water features include North Walnut Creek, South Walnut Creek, and Woman Creek, which are ephemeral streams draining the main site facilities in a west-to-east pattern.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- The Denver Water Board, via the Ralston Reservoir and the South Boulder Diversion Canal, supplies water for the site.
- Walnut Creek receives treated wastewaters.
- No contaminants in the surface water exceeded comparison criteria in 1992.
- Major groundwater units include, from deep to shallow, the Laramie-Fox Aquifer, a shale aquitard (upper unit of the Laramie Formation), the Arapahoe Formation Aquifer, and the surficial Rocky Flats Alluvium. No aquifers beneath the site are sole source aquifers.
- In 1992, 12 contaminants in the groundwater exceeded comparison criteria.
- Existing facilities at RFETS lie outside the 500-year floodplain.

Geology and Soils

- The site lies on the eastern edge of the Rocky Flats Plateau, which flanks the eastern edge of the Front Range of the Rocky Mountains. Elevation is approximately 6,000 feet.
- Major underlying rock units include the Pierre Shale and Fox Hills Sandstone. RFETS is situated on the Rocky Flats Alluvium, which varies in thickness up to 100 feet and provides a gravelly cover over bedrock.
- The surface soils at the site consist of clay, cobbly clay, and sandy loams. The soils are moderately deep, well drained, and have moderate to low permeability.
- The Golden Fault is west of the site.
- Geologic hazards include little or no risk from subsidence, landslides, or earthquakes.

Ecological Resources

- The Rocky Flats Buffer Zone is mostly virgin grassland with relict tallgrass species on the western side. The site is in the transitional area, or ecotone, between the Rocky Mountains and the High Plains. The vegetation and animal populations have high biodiversity.
- Jurisdictional wetlands were designated and mapped by the U.S. Army Corps of Engineers in 1995. Some 1,100 wetlands comprising about 195 acres were mapped. Other small wetlands exist at the site.
- The federally listed threatened bald eagle and endangered American peregrine falcon (both State-endangered) have been reported at the site. Nine federal C2 (potentially listable) species occur. A threatened plant, *Spiranthes diluvalis* (Ute ladies' tresses), has been searched for, but not found, for three growing seasons. Extensive observations have been made of the Preble's meadow jumping mouse, a species the U.S. Fish and Wildlife Service was petitioned to list in 1994. Potential habitats for other species of concern exist at the site. Consultation on water depletions of the South Platte River by site operations is in progress.

Socioeconomic Conditions

- The ROI for RFETS comprises Jefferson, Adams, Arapahoe, Boulder, and Denver Counties. These counties are the residence of 92.5% of the site's employees.
- Total site employment in 1991 was 7,365. Total ROI employment by place of work in 1991 was 1,198,525.
- The ROI unemployment rate in 1991 was 4.5%.
- The ROI per capita income in 1990 was $20,961.
- The total population in the ROI in 1991 was 1,790,600. Population demographics: Native Americans—0.8%; urban—95%.

- Housing: owner-occupied—60.8%; renter-occupied—39.2%.
- Sensitive populations: children (under 15 years old)—21.7%; women of child-bearing age (ages 15 to 44)—25.4%; adults over 65—9.3%.

Environmental Justice

- Minorities—Figure C.4–19.
- Below poverty level—Figure C.4–36.
- Presence of Federally recognized Native American Tribes: Although not located in the RFETS ROI, the Arapaho and Cheyenne have expressed an interest in DOE's waste management strategy.

Land Use

- The site occupies approximately 6,500 acres, of which 498 acres are occupied by operational facilities and 6,002 acres are undeveloped; of the undeveloped land, approximately 5,753 acres are available for future site development.
- Land use immediately surrounding the site on three sides is mostly rural open space. Land uses immediately beyond these open spaces are grazing agricultural, industrial, mining, and low-density residential. Residential areas within 5 to 10 miles are growing rapidly.

Infrastructure

- The Denver Municipal Water District provides an average of 0.272 million gallons of water per day from the Ralston and Gross Reservoirs.
- An onsite wastewater treatment system consisting of primary, secondary, and tertiary treatment and using an activated sludge process receives an average of 0.15 million gallons of sewage per day.
- The Public Service of Colorado's Valmont and Cherokee Generating Station, via electricity and gas, provides power; the average loads are 18.3 megawatts of electricity and 1,750 million cubic feet of gas per day.
- Transportation in the region consists of roads and interstates (such as nearby State Route 93) and rail lines intersecting in Denver, a major railway hub.

Cultural Resources

- Native American groups have lived in the RFETS area since about 10,000 years ago. European occupation of the region began in the late 19th century.

- Portions of the site have been subject to a comprehensive cultural resource survey. Several historic and prehistoric archaeological sites have been identified. The site contains no recorded standing structures but has the potential to contain traditional cultural properties.

4.4.14 SANDIA NATIONAL LABORATORIES—ALBUQUERQUE, NEW MEXICO

Sandia National Laboratories, New Mexico (SNL-NM), is immediately southeast of Albuquerque, New Mexico, on Kirtland Air Force Base (KAFB). SNL-NM occupies two parcels of land on KAFB, which have been allocated to DOE. These parcels total 2,820 acres. SNL-NM is a research and development laboratory with a primary mission of developing, engineering, and testing nonnuclear components of nuclear weapons. SNL-NM is operated for DOE by Sandia Corporation, a subsidiary of Lockheed/Martin Corporation. The current workforce at the site consists of 40 DOE employees and 8,556 prime contractor employees. SNL-NM is shown in Figure 4.4–14.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 610,714 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0034 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.020 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Bernalillo County, in which SNL-NM is located, is classified by EPA as a nonattainment area for the criteria pollutant carbon monoxide. The county is in attainment for the other five criteria air pollutants.
- Major sources of air pollution at the site include vapor degreasers, solvents for cleaning benches, gasoline dispensing facilities, paint spray booths, and solvents vented from the Hazardous Waste Management facility fume hoods and bulking operations.
- Prevailing winds are from the north with a frequency of 10%. The dominant windspeed range is 5 to 7 mph, with an occurrence of almost 38%. The frequency of calm winds is 8%. Average monthly temperatures range from 35 to 78.8°F. Average annual precipitation is 8 inches.

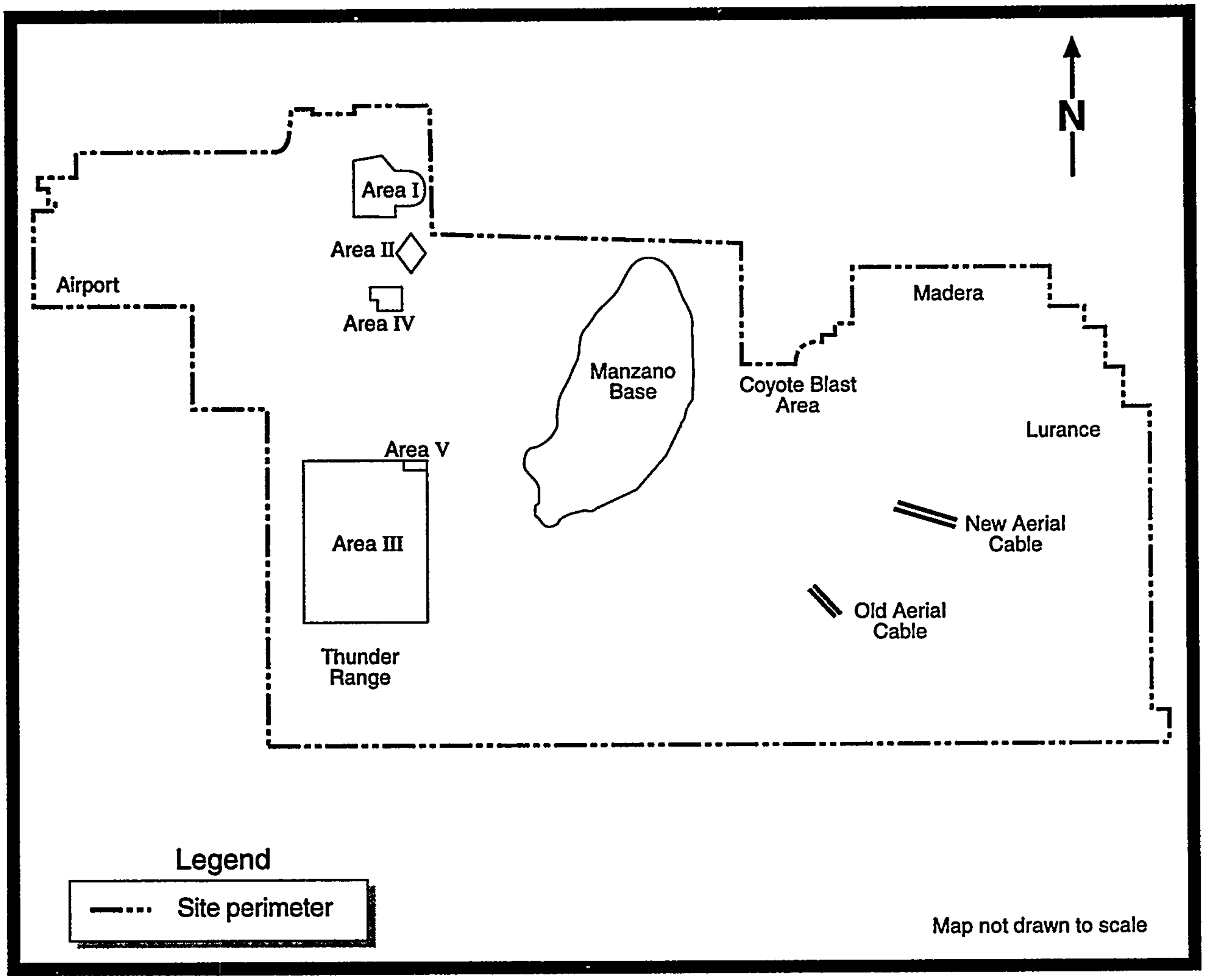

Figure 4.4–14. Sandia National Laboratories-New Mexico

Water Resources

- Major surface water features include the Rio Grande (6 miles from the western edge of KAFB) and onsite intermittent drainages such as Tijeras Arroyo and Arroyo del Coyote.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- The city of Albuquerque and KAFB wells supply water for the site.
- The city of Albuquerque wastewater treatment plant and surface water impoundments receive wastewater.
- In 1992, surface water monitoring showed two parameters above their comparison criteria.
- The major groundwater unit is the Valley Fill Aquifer, consisting of unconsolidated and semiconsolidated sands, gravels, silts, and clays. No sole source aquifers exist in the ROI.

- Groundwater monitoring in 1992 showed that comparison criteria were exceeded for five parameters.
- All active facilities are located well outside the Rio Grande's 500-year floodplain.

Geology and Soils

- The topography at the site is generally flat, except for the steep-sided arroyos that cut through the mesa area.
- Major rock units below the eastern section of the site include basement rocks. Most of the rest of the site is underlain by the Santa Fe Group, which includes gravels, sands, silts, and clays deposited in a basin formed by the uplift of the mountains to the east. Ortiz gravel and Rio Grande fluvial deposits are surficial deposits in some places.
- The soils present include sandy, gravelly, loamy, stony, and very cobbly soils. Basalt, sandstone, and limestone outcrops are also present.
- Four faults, including two capable ones, cut across the site.
- The site is in an area characterized by high seismic activity but of low magnitude and intensity. Studies indicate that a nondamaging earthquake may be expected every 2 years, with a damaging event every 100 years.
- The potential for damage from volcanic activity is small.

Ecological Resources

- Vegetation includes grassland, arroyo banks/dissected terrace, and grassland on dune sand. Grassland vegetation dominates. Dominant shrub species are sand sagebrush and four-wing saltbush, which are widespread in the western United States. Unique habitat includes arroyos.
- Wetland habitat is extremely limited on KAFB.
- No known Federally listed threatened or endangered species have been found at SNL. The Federal and State endangered peregrine falcon could exist in woodland or canyons. Two candidate species exist and one candidate species potentially exists on KAFB; three State-listed endangered cacti are located within KAFB; five State-listed endangered fauna exist or potentially exist on KAFB; and four plants classified as State Priority 1 are located in the vicinity of KAFB.

Socioeconomic Conditions

- The ROI for SNL-NM includes Bernalillo, Cibola, Sandoval, Santa Fe, Torrance, and Valencia Counties. At least 90% of the site's employees reside in these counties.

- Total site employment in 1992 was 8,596. Total ROI employment by place of work in 1990 was 393,398.
- The ROI unemployment rate was 7.0% in 1991.
- The ROI per capita income in 1990 was $16,281.
- The total population in the ROI in 1990 was 722,138. Population demographics: Native Americans—5.85%; urban—85.3%.
- Housing: owner-occupied—67.88%; renter-occupied—32.12%.
- Sensitive populations: children (under 15 years old)—23%; women of child-bearing age (ages 15 to 44)—23.1%; adults over 65—10.3%.

Environmental Justice

- Minorities—Figure C.4–20a.
- Below poverty level—Figure C.4–37.
- Presence of Federally recognized Native American Tribes: Isleta, Laguna, Sandia, Santa Ana, Santo Domingo, and Zia Pueblos.
  Tribal lands—Figure C.4–20b.

Land Use

- The site occupies approximately 2,820 acres, of which 175 acres are currently developed and 206 acres are available for future site development.
- Land use surrounding the site includes the Kirtland Air Force Base.

Infrastructure

- Onsite wells provide an average of 1.0 million gallons of water per day.
- The City of Albuquerque sewer system receives sewage; a site load of 0.548 million gallons per day was recorded in 1991.
- KAFB, which purchases electricity from the Public Service Company of New Mexico and the Western Area Power Administration, supplies power. The current site load is 34.5 megawatts. The Gulf Gas Utilities Company supplies natural gas.
- The ROI contains local road and rail networks. The site is 6 miles southeast of downtown Albuquerque. I-40 and I-26 intersect within the city limits. There is no direct rail access to the site.

Cultural Resources

- The State Historic Preservation Office has not evaluated the site for unrecorded archaeological sites, architectural resources, or traditional cultural properties.

4.4.15 SAVANNAH RIVER SITE—AIKEN, SOUTH CAROLINA

The Savannah River Site (SRS) is approximately 25 miles southeast of Augusta, Georgia, and 20 miles south of Aiken, South Carolina, in Aiken, Barnwell, and Allendale Counties in southwest-central South Carolina. It is on approximately 198,000 acres of land in a principally rural area, with most of the land serving as a forestry research center. SRS was established in 1950 by the Atomic Energy Commission. The site is currently operated by Westinghouse Savannah River Company. SRS is shown in Figure 4.4–15.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 620,618 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.140 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 6.40 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- The areas encompassed by, and the counties surrounding, SRS are classified by EPA as attainment areas for all six of the National Ambient Air Quality Standards criteria air pollutants.
- The major source of criteria air pollutants are nine coal-burning and four fuel-oil-burning boilers, and the processing facilities for fuel and target fabrication. Non-SRS sources of toxic air pollutants consist primarily of industrial installations, small manufacturing shops, and residential wood combustion.
- Prevailing winds at the Bush Field Airport in 1992 are uniformly distributed with winds from the west-southwest 7% of the time and from the west-northwest 6% of the time on a yearly basis. The highest occurrence of windspeed is from 5 to 7 mph, with an annual occurrence of 35%. The annual average temperature is 66°F), with seasonal temperatures ranging from an average summertime daily maximum of 90.8°F to an average daily minimum in January of 37.9°F.

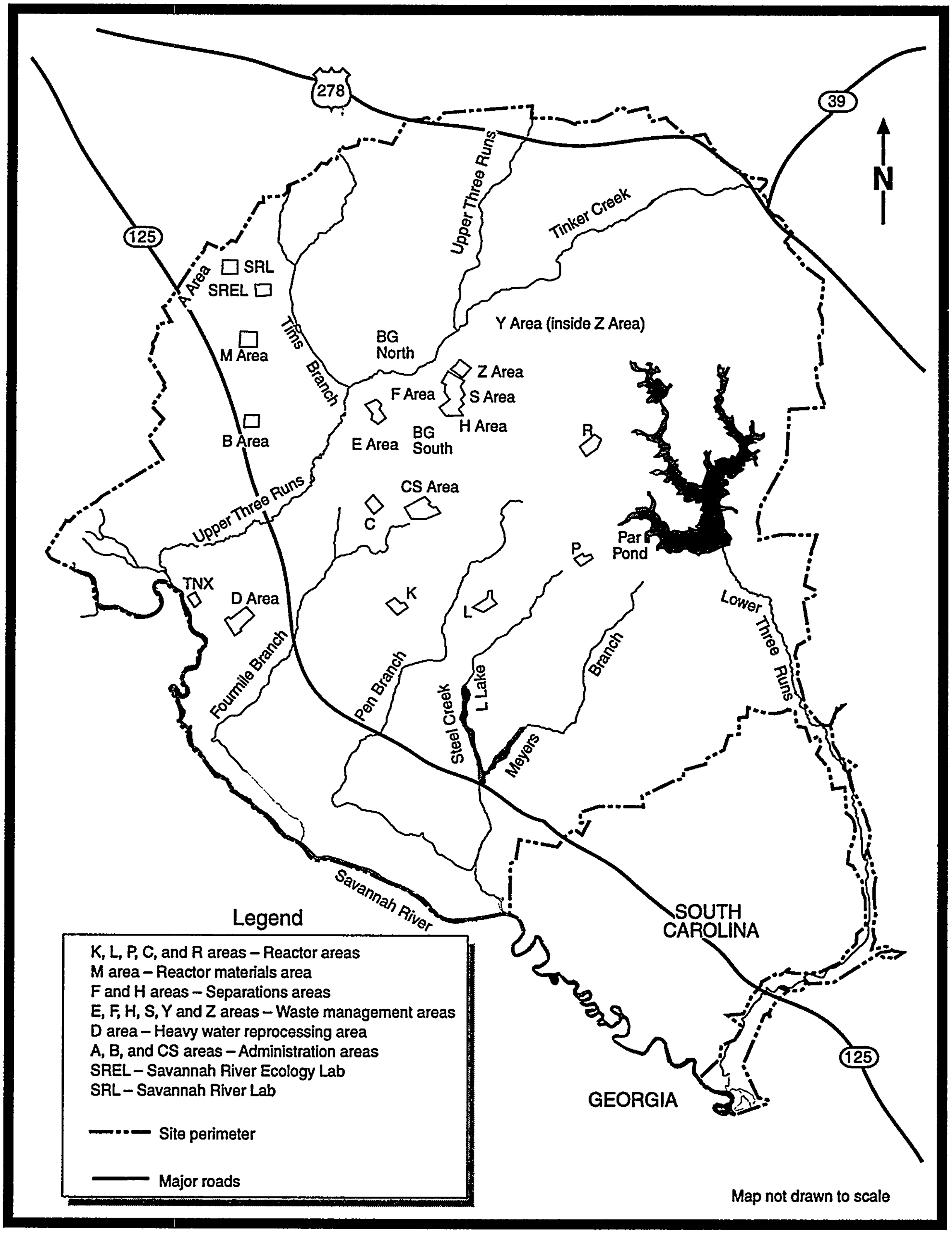

Figure 4.4–15. Savannah River Site

Water Resources

- Major surface water features include the Savannah River (which runs along the southwestern SRS border for 20 miles); onsite drainages such as Upper Three Runs, Fourmile Branch, Beaver Dam Creek, Pen Branch, Steel Creek, and Lower Three Runs; and numerous Carolina bays.
- No Federally designated Wild and Scenic Rivers exist in ROI.
- Groundwater wells and the Savannah River supply water for the site.
- Onsite streams and the Savannah River receive treated wastewater.
- Major groundwater units are the interbedded sandy clays and clayey sands of the coastal plain sediments. The sandy beds generally form aquifers, and the clay-rich beds act as aquitards. No sole source aquifers occur in the ROI.
- Onsite groundwater monitoring in 1992 showed that 42 parameters exceeded comparison criteria. Groundwater monitoring data indicate that contaminant plumes have not migrated into offsite water.
- The 100-year floodplain does not encroach on existing facilities.

Geology and Soils

- The topography of the area is generally flat, with some rolling hills and knolls. Elevations range from 85 to 427 feet above mean sea level.
- Major rock units include, from oldest to youngest, the crystalline basement rocks, the Dunbarton Triassic Basin, and the Atlantic Coastal Plain sediments.
- The soils in the area are primarily sandy loams that occur on alluvial terraces of the Savannah River and on the Aiken Plateau.
- Several interbasinal faults are located in the down-faulted Dunbarton Triassic Basin. However, no conclusive evidence exists of recent displacement along any fault within 186 miles of SRS.
- Two major earthquakes have occurred within 186 miles of the site. The probability of future seismic damage is moderate.

Ecological Resources

- Major plant communities include cypress-gum and lowland hardwood swamps, sandhills, and old agricultural fields. Ninety percent of SRS land cover is comprised of upland pine forests and bottomland hardwood forests. Important terrestrial habitats include old fields, sandhills, upland pine forests, bottomland and upland hardwood forests, and swamp forests. Longleaf pine/wiregrass communities support sensitive species, such as the red-cockaded woodpecker. SRS was designated a National Environmental Research Park in 1972.

- SRS contains approximately 43,000 acres of wetlands (20% of SRS), consisting of emergent marsh, cypress/tupelo, bottomland hardwood, and open water. These wetlands include the Savannah River swamp (about 10,000 acres) and over 200 Carolina bays scattered throughout the SRS.
- Federal and State endangered Kirtland's warbler, peregrine falcon, wood stork, red-cockaded woodpecker, and shortnose sturgeon are present on SRS. The Federally endangered smooth coneflower is also present. Two Federal threatened species and 11 candidate species are found on the site. The State-endangered Rafinesque's big-eared bat is present as well as the State-threatened Bewick's wren. Over 50 plants and animals on the State list are found on SRS. Additional listed species are located near SRS.

Socioeconomic Conditions

- The ROI for SRS includes Aiken, Barnwell, Allendale, and Bamberg Counties in South Carolina and Burke, Columbia, Richmond, and Screven Counties in Georgia. At least 90% of the site's employees reside in these counties.
- Total site employment in 1990 was 19,201. Total ROI employment by place of work in 1990 was 254,777.
- The ROI unemployment rate was 8.4% in 1991.
- The ROI per capita income in 1990 was $15,837.
- The total population in the ROI in 1990 was 460,028. Population demographics: Native Americans—0.2%; urban—69.6%.
- Housing: owner-occupied—67.1%; renter-occupied—32.9%.
- Sensitive populations: children (under 15 years old)—23.7%; women of child-bearing age (ages 15 to 44)—24.3%; adults over 65—10.3%.

Environmental Justice

- Minorities—Figure C.4–21.
- Below poverty level—Figure C.4–38.
- Presence of Federally recognized Native American Tribes: Three Native American groups, the Yuchi Tribal Organization, the Nubiunal Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy, have expressed general concerns about SRS and the Central Savannah River Area regarding several plant species traditionally used in tribal ceremonies.

Land Use

- The site occupies approximately 198,000 acres of land, most of which serves as a forestry research center. SRS was designated a National Environmental Research Park in 1972. Of the total area, approximately 15,840 acres are developed and 182,160 are undeveloped; of the undeveloped land, approximately 145,400 acres are available for future site development.
- Land use surrounding the site is predominantly rural.

Infrastructure

- Onsite wells provide an average of 1.6 million gallons of water per day.
- Onsite treatment plants receive an average of 0.5 million gallons of sewage per day.
- South Carolina Gas and Electric Company and onsite generation provide power; the current site load is 130 megawatts.
- Transportation in the region consists of local access roads (such as U.S. 278 and State Route 125) and major roads (such as Interstates 20 and 95). The Seaboard Coast and Southern Railroads are the primary providers of rail service to the SRS region, including onsite rail spurs.

Cultural Resources

- Native American occupation of the area began about 11,000 years ago.
- Over 800 prehistoric sites and about 400 historic sites have been identified at SRS.
- Fifty-five sites have been determined eligible for the National Register of Historic Places.

4.4.16 Waste Isolation Pilot Plant—New Mexico

The Waste Isolation Pilot Plant (WIPP) is in Eddy County in southeastern New Mexico, approximately 25 miles east-southeast of Carlsbad in an area known as Los Medanos (The Dunes). The area, which totals 10,245 acres, is a sparsely inhabited plateau with little water and limited land uses. WIPP is a DOE facility authorized in 1980 to demonstrate the technical and operational principles involved in the permanent disposal of defense-generated transuranic waste. WIPP is shown in Figure 4.4–16.

Human Health

- Because WIPP is not open for TRUW disposal, only preoperational radiation surveillance has been conducted to establish background information at the site. Radiological measurements will also be performed to monitor any radionuclide release from the site after its opening for TRUW disposal.

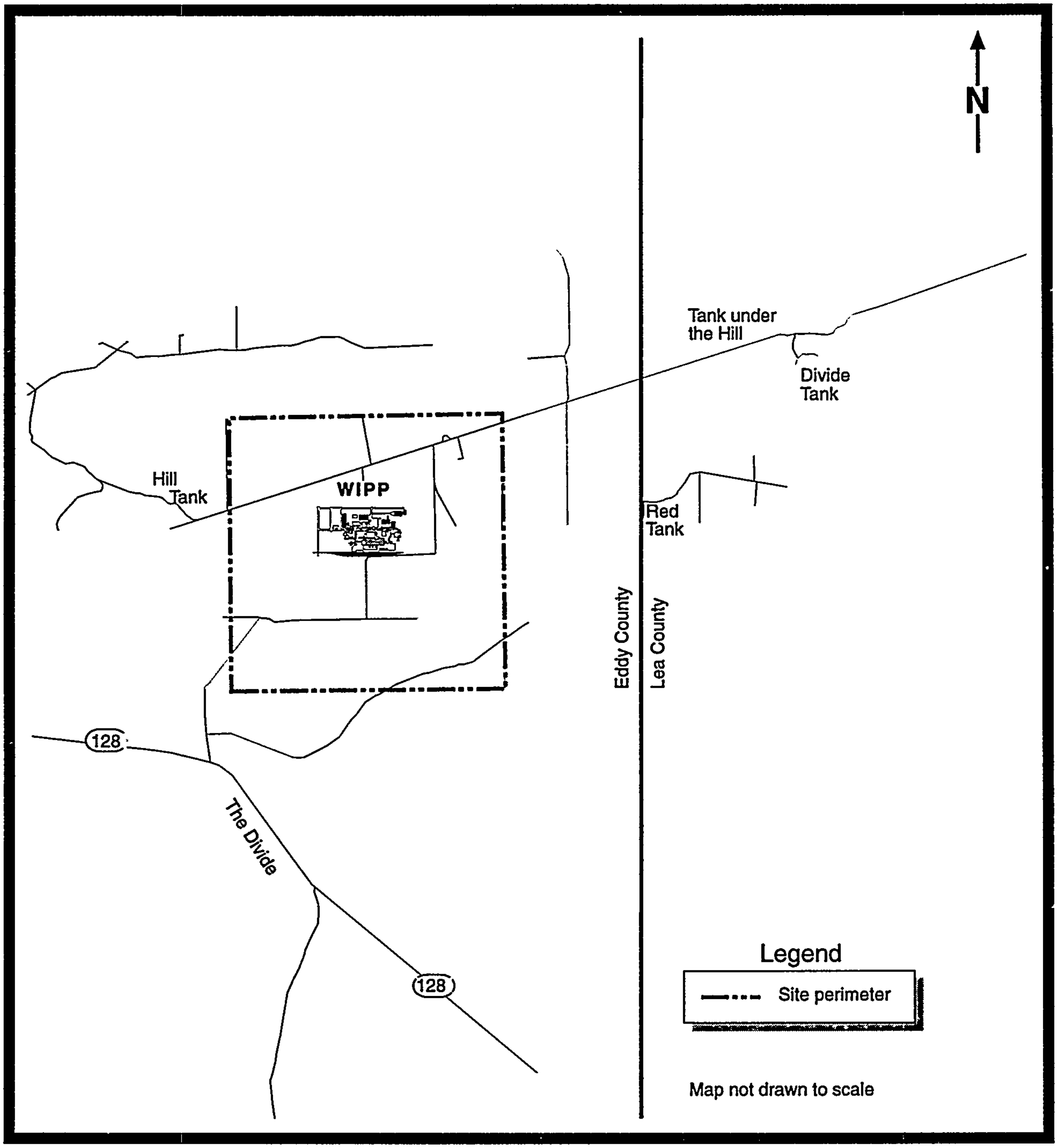

Figure 4.4–16. Waste Isolation Pilot Plant

- The ROI population used for PEIS health risk analyses is 99,889.

Air Quality

- Eddy County is currently classified by EPA as an attainment area for all six of the criteria air pollutants.
- Operations involving radioactive waste are expected to begin upon receipt of wastes shipped to WIPP for disposal. These operations would be the major source of air pollution at the site.
- Prevailing winds are from the southeast approximately 13% of the time, and the dominant windspeed ranges from 5 to 7 mph with an occurrence of almost 38%. The frequency of calm winds less than 2 mph is 4%. The average annual temperature for the WIPP area in 1992 was 63°F. The annual precipitation in 1992 was 16.58 inches, which is 4.33 inches above the long-term average for the area.

Water Resources

- Major surface water features include the Pecos River (14 miles west of the site); surface water runoff impoundments called "tanks" scattered throughout the nearby area; Laguna Grande de la Sal (10 miles south of the site), which is a large catchment basin for limited surface drainage; and artesian saline springs.
- No Federally designated Wild and Scenic Rivers exist in the ROI.
- The city of Carlsbad supplies water for the site.
- The WIPP sewage lagoon, a zero-discharge treatment facility, receives wastewaters.
- Surface water analysis in 1987 for various metals and organics showed elevated levels of six contaminants resulting from the natural saline springs in the area. Radionuclide concentrations fall within expected levels.
- Groundwater units include, from deepest to shallowest, the Bell Canyon Formation (water-bearing), the Castile Formation, the Rustler Formation (containing five water-bearing zones including the Culebra Dolomite), and the Dewey Lake Red Beds (sand beds). No sole source aquifers occur at the site. In the vicinity of WIPP, water is of low quality (ranging from brackish to brine). There are no aquifers on the WIPP site.
- Groundwater monitoring in 1992 showed naturally high concentrations of constituents in the Culebra Dolomite and seven constituents in the Dewey Lake Red Beds. Maximum concentrations of constituents in groundwater are provided in Table 2.21–3 of the affected environment technical report (DOE, 1996).
- WIPP is more than 400 feet above the floodplain of the Pecos River, well outside areas that may be flooded.

Geology and Soils

- The site is on a slight hummocky plain covered with caliche and sand within the Delaware Basin of the Pecos Valley. Elevations range from 3,250 to 3,570 feet.
- Major rock units include, from oldest to youngest, the Bell Canyon Formation (sandstones, shales, siltstones, and limestones), the Castile Formation (anhydrite and halite), the Salado Formation (anhydrite and halite), the Rustler Formation (anhydrite, siltstone/claystone, halite, and carbonate), the Dewey Lake Red Beds (siltstones and claystones, with subordinate sandstones), the Santa Rosa Sandstone, the Gatuna Formation sandstones, the Mescalero caliche, and Recent-age sands.
- Soils are made up of noncalcareous loose sands. Permeability and the potential for wind erosion are very high.
- Because of karst features in the area, dissolution and subsidence has occurred, and may continue to occur. These events are limited in extent and do not affect the integrity of the Salado Formation near repository depth.
- The Delaware Basin is considered to be tectonically stable. No surface faulting is known at the site.

Ecological Resources

- WIPP is characterized by stabilized sand dunes. Dominant vegetation includes Harvard Shin oak, mesquite, sand sage and plains yucca, and numerous species of forbs and perennial grasses. Dominant shrubs are deep-rooted species with extensive root systems.
- Wetlands are not present at WIPP.
- The Federal and State endangered American peregrine falcon and the Federal threatened and State endangered bald eagle may be located at WIPP, as well as four Federal Notice of Review species (one is State threatened). No critical habitat for terrestrial endangered species has been identified at WIPP.

Socioeconomic Conditions

- The ROI for WIPP comprises Eddy, Otero, Chaves, and Lea Counties in New Mexico and Culberson and Loving Counties in Texas. Ninety percent of the site's employees reside in these counties.
- Total site employment for 1990 was 932. Total ROI employment by place of work in 1990 was 99,707.
- The ROI unemployment rate in 1991 was 6.1%.
- The ROI per capita income in 1990 was $13,557 (1990 dollars).
- The total population in the ROI in 1990 was 217,661. Population demographics: Native Americans—1.83%; urban—73.64%.
- Housing: owner-occupied—69.2%; renter-occupied—30.8%.

- Sensitive populations: children (under 15 years old)—26.4%; women of child-bearing age (ages 15 to 44)—21.4%; adults over 65—12.3%.

Environmental Justice

- Minorities—Figure C.4–22.
- Below poverty level—Figure C.4–39.
- Presence of Federally recognized Native American Tribes: Although not located in the WIPP ROI, the Mescalero Apache Tribe has expressed an interest in DOE's waste management strategy.

Land Use

- The site occupies approximately 10,245 acres of land, of which approximately 10,210 acres are available for future site development, although a 1-mile buffer zone is planned to be provided around the area above the maximum extent of underground development.
- Land surrounding the site is sparsely inhabited, with limited land uses.

Infrastructure

- An offsite well system from the city of Carlsbad provides an average of 0.075 million gallons of water per day.
- An onsite sewage lagoon receives an average of 0.012 million gallons of sewage per day.
- The Southwestern Public Service Company supplies power; the current site load is 4,579 kilovolt-amperes.
- Direct access to the site is available from Routes 128 and 31. A rail spur to the site connects to the Atchison, Topeka, and Santa Fe Railroad.

Cultural Resources

- Since 1976, a total of 98 archaeological sites and numerous isolated artifact finds have been recorded within the 16-square-mile WIPP site.

4.4.17 West Valley Demonstration Project—West Valley, New York

The West Valley Demonstration Project (WVDP) occupies 220 acres of the Western New York Nuclear Services Center (WNYNSC) in West Valley, New York, a rural setting approximately 31 miles south of Buffalo, in Cattaraugus County, a largely rural area. The WNYNSC was established in 1961. The New

York State Energy Research and Development Authority formed a private company—Nuclear Fuel Services, Inc. (NFS)—to construct and operate a nuclear fuel reprocessing plant. NFS leased WNYNSC, constructed the site, and began operations in 1966 to recycle fuel from commercial and Federally owned reactors. In the late 1970s, the site was shut down. WVDP is shown in Figure 4.4–17.

Human Health

- The ROI population used in the PEIS analyses to determine human health risk was 1,698,391 based on 1990 Census data (DOC, 1991, 1992b,c).
- The radiation dose from airborne radionuclides to a maximally exposed individual (MEI) was 0.0003 mrem according to the *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992* (DOE, 1994a).
- The collective radiological dose from airborne radionuclide emissions to the site ROI health risk population was 0.011 person-rem according to the 1992 DOE summary report (DOE, 1994a).

Air Quality

- Cattaraugus County, in which WVDP is located, is classified by EPA as an attainment area for all six criteria air pollutants.
- Major sources of air pollution at the site are radiological and include the main ventilation stack, cement solidification system ventilation stack, contact size-reduction facility ventilation stack, and supernatant treatment system ventilation stack.
- Prevailing winds were from the south-southeast with a frequency of 17% in 1992. The frequency of calm winds was 1%. Precipitation for the year was almost 7 inches above the annual average of 41 inches.

Water Resources

- Major surface water features include Cattaraugus Creek (2.4 miles from the site), Buttermilk Creek (0.5 mile from the site), and onsite tributaries (Quarry Creek, Erdman Brook, and Frank's Creek). The WVDP site and these streams are within the Cattaraugus Creek drainage basin, which ultimately flows into Lake Erie.
- No federally designated Wild and Scenic Rivers exist in the ROI.
- Two reservoirs, formed by damming tributaries to Buttermilk Creek, supply water for the site.
- Erdman Brook receives treated wastewater.
- One constituent was above comparison criteria in surface waters in 1991.

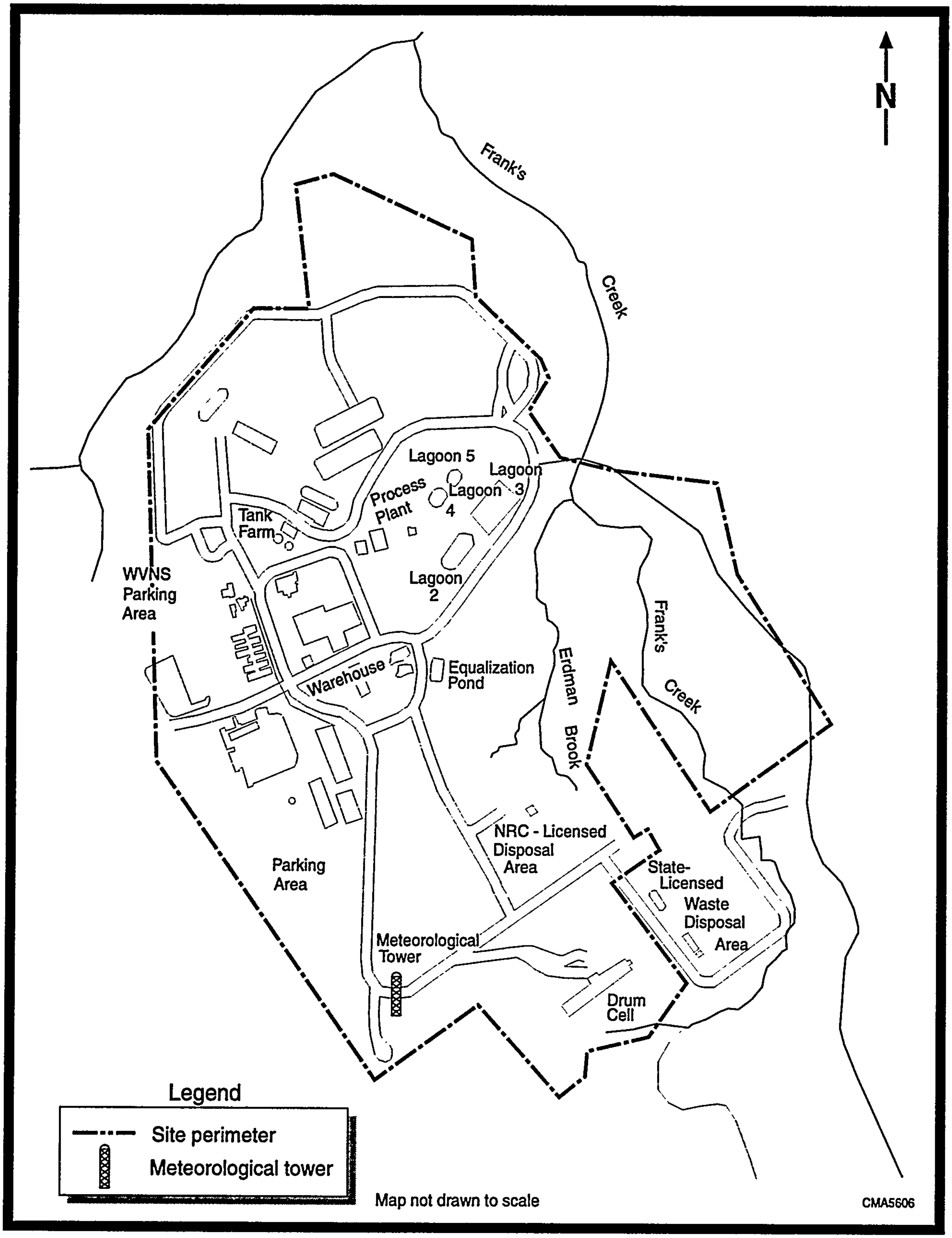

Figure 4.4–17. West Valley Demonstration Project

- Major groundwater units include a shallow aquifer composed of weathered Lavery till and alluvial gravels and a bedrock aquifer consisting of decomposed shale and rubble. The Cattaraugus Creek Basin Aquifer System is considered a sole source aquifer.
- Groundwater monitoring in 1991 showed that all parameters except gross beta and tritium were within comparison criteria. Monitoring at 10 offsite residential wells indicated no evidence of contamination by activities at WVDP.
- No safety-related WVDP facilities are in a 100-year floodplain.

Geology and Soils

- The topography at the site is generally gently rolling, with slopes between 5 and 15% and an average elevation of 1,300 feet above National Geodetic Vertical Datum.
- Major rock units include, from oldest to youngest, crystalline basement rocks; the Canadaway and Conneaut Groups (shales and siltstones); the Kent and Olean clayey silt tills; a lacustrine unit of silt, clay, sand, and gravel; and the Lavery silty clay till. Alluvial sands and gravels cover glacial till in some places.
- The major soils present include a well-drained gravelly loam and a poorly drained silt loam.
- No faulting of any consequence is recognized within the site.
- The site is in a region that has experienced a moderate amount of minor seismic activity.
- The potential for damage from volcanic activity or subsidence is small.
- The site is currently experiencing some erosion.

Ecological Resources

- Vegetation communities at WVDP include mixed hardwood forest (40% of the site), evergreen forest, bottomland forest, old-field successional areas, and forest-stage successional areas. WVDP is equally divided between forest and abandoned farm fields, which are becoming re-established with native vegetation. The State has designated the site as critical habitat because white-tail deer use it extensively as a wintering area. Unique habitats include rock faces.
- Delineated wetlands total approximately 35 acres and include wet meadows, emergent marshes and pond fringes, shrub swamps, forested swamps, and bogs and fens. A riparian area on Cattaraugus Creek is recognized by the State as Habitat Significant for Wildlife.
- No Federal-listed threatened or endangered species or critical habitats are found on WVDP. No State-listed endangered species have been recorded on the site, but 1 State threatened bird species, 38 plant species listed as protected, and 31 species considered exploitable vulnerable have been recorded on the

site. The Federal and State endangered Indiana bat, 3 State endangered, 4 State threatened, and 16 State species of special concern may potentially exist on the site.

Socioeconomic Conditions

- The ROI for WVDP comprises Cattaraugus and Erie Counties. Ninety-six percent of the site's employees reside in these counties.
- Total site employment in 1990 was 1,100. Total ROI employment in 1990 was 569,246.
- The ROI unemployment rate in 1991 was 8%.
- The ROI per capita income in 1990 was $17,937.
- The total population in the ROI in 1990 was 1,052,766. Population demographics: Native Americans—0.7%; urban—84%.
- Housing: owner-occupied—64.4%; renter-occupied—35.6%.
- Sensitive populations: children (under 15 years old)—19.9%; women of child-bearing age (ages 15 to 44)—23%; adults over 65—15.1%.

Environmental Justice

- Minorities—Figure C.4–23a.
- Below poverty level—Figure C.4–40.
- Presence of Federally recognized Native American Tribes: Seneca Nation.
  Tribal lands — Figure C.4–23b.

Land Use

- The site occupies approximately 220 acres of land; approximately 165 acres are available for future site development.
- Land use surrounding the site is predominantly rural. The site occupies a portion of the WNYNSC.

Infrastructure

- An onsite facility supplied from a reservoir provides an average of 0.07 million gallons of water per day.
- An onsite wastewater treatment plant receives an average of 0.07 million gallons of sewage per day.
- The Niagara Mohawk Power Company supplies electrical service; the WVDP electric load in December 1993 was 2.9 megawatts. Natural gas service is provided by National Fuel Gas Distribution Corporation; the natural gas usage in December 1993 was 15,880 British Thermal Units.

- Access to I-90 from WVDP is by Route 219, 5 miles west of the site. Route 17 is located 20 miles south of the site. An inactive rail spur is available on the site.

Cultural Resources

- The undeveloped portions of WVDP have not been evaluated by the New York State Historic Preservation Office.

4.5 Brief Descriptions of Other Sites

In this section, information is presented to characterize the activities that have produced waste at other sites. This includes all sites except the 17 major sites and those sites located within the same geographical location as one of the 17 major sites.

Ames Laboratory—Ames, Iowa. Ames Laboratory grew out of Iowa State University's involvement in the Manhattan Project starting in 1942. Ames furnished most of the uranium used in the first successful nuclear chain reaction in 1942. Uranium production continued throughout World War II. Current research includes innovative materials, superconductors, and environmental restoration technologies. Responsibilities at this Site include remediation of a chemical disposal site (1 acre) and a diesel fuel oil underground storage tank (1 acre). The laboratory occupies approximately 15 acres at the University.

Battelle Columbus Laboratories—Columbus, Ohio. Battelle Columbus Laboratories is made up of two major research complexes covering 10 acres, one in the city of Columbus and one in rural Madison County, Ohio. The Columbus Site houses corporate offices and general research laboratories. The other site is made up of a number of facilities formerly dedicated to nuclear research. Since mid-1943, the Battelle Memorial Institute has continuously performed contract research and development work for DOE and its predecessor agencies. The Battelle Columbus Laboratories are privately owned. DOE no longer needs the facilities and is obligated contractually to remove the contamination so that the laboratories can be used by Battelle without radiological restriction. Fifteen buildings, or portions thereof, and associated soil areas are radioactively contaminated as a result of work done under government contract.

Bettis Atomic Power Laboratory—West Mifflin, Pennsylvania. Bettis Atomic Power Laboratory is located on a 202-acre tract in West Mifflin, Pennsylvania, about 8 miles southeast of Pittsburgh. Bettis is one of four DOE Laboratories participating in the joint DOE and Department of the Navy Naval Nuclear Propulsion Program. The Laboratory is operated for DOE by the Westinghouse Electric Corporation and is engaged solely in designing and developing naval nuclear propulsion plants. Laboratory operations include developing and testing nuclear fuel materials and reactor materials including radiochemical analyses.

Charleston Naval Shipyard—Charleston, South Carolina. The Charleston Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program of DOE and the Department of the Navy. The activity at the Charleston Naval Shipyard is being phased out as the operation is shut down.

Colonie Interim Storage Site—Colonie, New York. The 10-acre Colonie Site was used to manufacture a variety of products from depleted uranium. Since termination of AEC contracts, work has been limited to fabrication of shielding components, ballast weights, and projectiles from depleted uranium. In 1983, Congress assigned DOE the responsibility for site cleanup. Radiological surveys conducted from 1983 through 1987 identified 56 vicinity properties requiring corrective actions. Remedial action is expected to be completed by 1998.

Energy Technology Engineering Center (ETEC)—Los Angeles, California. ETEC is operated by the Rocketdyne Division of Rockwell International Corporation for DOE at 50 DOE-owned facilities located on a 90-acre area within Area IV of the Santa Susana Field Laboratory (SSFL) site. In 1946, the ETEC facilities began work in nuclear energy research and development. Small test and demonstration reactors and critical assemblies were built and operated, reactor fuel elements were fabricated, and used reaction fuel elements were disassembled and the cladding was removed from around the fuel. Since 1956, ETEC facilities were used to conduct manufacturing, engineering, and R&D activities for the AEC, the Energy Research and Development Administration (ERDA), and DOE. In 1966, ETEC was associated with the Liquid Metal Fast Breeder Program. Since 1987, no work with nuclear materials has been done at ETEC, and the only work related to its earlier operations has been cleanup and decontamination of the remaining inactive nuclear facilities. Currently all ETEC projects involve decontamination and decommissioning.

Fermi National Accelerator Laboratory—Chicago, Illinois. Fermi National Accelerator Laboratory (Fermi) is operated by a consortium of U.S. and Canadian universities for DOE. It explores the fundamental structure of matter using high-energy accelerators. Fermilab's accelerator, the Tevatron, is the world's highest energy accelerator. Environmental restoration includes cleanup of polychlorinated biphenyls (PCBs).

General Atomics—San Diego, California. General Atomics (GA) Technologies was founded in 1955 and was one of the first private organizations to engage in fusion power research. DOE awarded a contract in January 1991 to GA to provide inertial confinement fusion (ICF) target component fabrication and technology development support to DOE for laboratories engaged in ICF experimental activities. DOE is responsible for the management, cleanup, and disposal of radioactive waste generated from DOE programs at this site, which is on less than 1 acre of land. Decontamination and decommissioning planning activities for the GA Hot Cell Facility were initiated in Fiscal Year (FY) 1992 and are expected to be completed by FY 1997.

General Electric Vallecitos Nuclear Center—Vallecitos, California. The Vallecitos Nuclear Center was used for mixed oxide fuel fabrication and development from 1962 to 1979. DOE is responsible for the management, cleanup, and disposal of the radioactive waste generated from DOE programs at this facility. Decontamination and decommissioning (D&D) planning activities for an alpha cell located within General Electric's Hot Cell Facility were initiated in FY 1992. D&D of the Hot Cell Facility has been delayed by waste disposition issues and is expected to be reinitiated in FY 1997.

Grand Junction Projects Office—Grand Junction, Colorado. The Grand Junction Projects Office (GJPO) supported the development of uranium ore processing and milling technology between 1942 and 1974. GJPO was accepted into the decontamination and decommissioning program in 1988. Remediation of the GJPO Site began in 1990 and, with the anticipated addition of 12 contaminated buildings in the program, is expected to be completed in FY 1998.

Inhalation Toxicology Research Institute—Albuquerque, New Mexico. The Inhalation Toxicology Research Institute (ITRI) covers about 135 acres on the Kirtland Air Force Base. The principal mission is to investigate human health effects from inhalation of airborne particulates, including fission products, fuel cycle actinides, insulating materials, and diesel exhaust. Radioactive waste is disposed at DOE-owned sites. Underground storage tank leaks have produced diesel oil contamination of the groundwater below lagoons used for the disposal of sanitary waste. Complete groundwater cleanup is expected by 1996.

Kansas City Plant—Kansas City, Missouri. Established in 1949, the Kansas City Plant (KCP), which covers 141 acres, manufactures rubber, plastic, electronic, and other nonnuclear parts for nuclear weapons. The plant also provides development hardware for research programs conducted at DOE laboratories. KCP has recently been assigned several additional missions as part of the nonnuclear consolidation of the DOE weapons complex. The facility was formerly used as an airplane engine production plant for the U.S. Department of Defense. Onsite groundwater, soil, and air release contamination has resulted from the use of solvents and spillage of transformer oils contaminated with polychlorinated biphenyls (PCBs). Complete cleanup of contaminated sites is expected by 2000 (except long-term and ongoing groundwater treatment).

Knolls Atomic Power Laboratory—Kesselring Site, West Milton, New York. The Knolls Atomic Power Laboratory, Kesselring (KAPL–K), is in Saratoga County near West Milton, New York, approximately 17 miles north of the city of Schenectady, 9 miles southwest of Saratoga Springs, and 13 miles northeast of Amsterdam. KAPL–K consists of 3,900 acres of Government-owned land. Facilities construction began in 1951, and the site was originally developed as a test site for liquid metal fast breeder reactors. In the early 1950s, the site was then developed for the Navy Nuclear Propulsion Program. KAPL–K's mission is to test prototype nuclear propulsion plants for submarines and surface ships and to train U.S. Navy Nuclear propulsion plant operators.

Knolls Atomic Power Laboratory—Niskayuna, New York. The Knolls Atomic Power Laboratory, Niskayuna (KAPL-N), is located on a 170-acre tract in Niskayuna, New York, about 2 miles east of Schenectady, on the south bank of the Mohawk river. KAPL-N is operated by KAPL, Inc., a wholly owned subsidiary of the Lockheed Martin Corporation under contract with DOE. KAPL consists of three sites: the Niskayuna and Kesselring sites in New York and the Windsor Site in Connecticut. These sites are engaged solely in research and development for the design and operation of naval nuclear propulsion plants in conjunction with the joint DOE and Department of the Navy Naval Nuclear Propulsion Program. The KAPL-N is the primary KAPL site, and its mission is to design and develop improved naval propulsion plants and reactor cores.

Knolls Atomic Power Laboratory—Windsor, Connecticut. The Knolls Atomic Power Laboratory, Windsor (KAPL-W), is located on a 10.8-acre tract about 5 miles north of Hartford, Connecticut, in the town of Windsor. The KAPL-W conducts full-scale testing of a pressurized-water naval nuclear propulsion plant and associated propulsion plant hardware, and trains personnel to operate these plants. This testing propulsion plant was shut down in March 1993 and has been defueled. The draft EIS for the disposal of this plant was published in June 1996.

Laboratory for Energy-Related Health Research—Davis, California. A less-than-1-acre DOE-owned facility located 1 mile from the main campus of the University of California, Davis, the Laboratory for Energy-Related Health Research investigates health effects of exposure to low levels of radiation. The removal, treatment, packing, and disposal of 35,000 gallons of sludge waste was completed in 1991-1992. Complete decontamination and decommissioning of the facilities is expected by FY 1995. Complete Comprehensive Environmental Response, Compensation, and Liability Act remedial actions are expected by 1997 at which time the Site will be released to the University.

Lawrence Berkeley Laboratory—Berkeley, California. The Lawrence Berkeley Laboratory (LBL) occupies a 133-acre site within the University of California, Berkeley, campus. The LBL site is leased by DOE through a series of 50-year lease agreements. The lab originated on the Berkeley campus of the University of California in 1931. From 1948 to 1972, the Laboratory was operated by the University of California for the U.S. Atomic Energy Commission (AEC). During this period, pioneering discoveries were made in nuclear and elementary particle physics, nuclear chemistry, biology, and nuclear medicine. Three of the basic modern types of accelerator—the cyclotron, the Alvarez Linear accelerator, and the synchrotron—were invented and developed at LBL. In 1972 the Lawrence Radiation Laboratory became the Lawrence Berkeley Laboratory with major funding from ERDA, which replaced the AEC. Today, LBL is operated as one of nine multi-program National Laboratories of the DOE. LBL's major role is to conduct basic and applied science research that is appropriate for an energy research Laboratory.

Mare Island Naval Shipyard—Vallejo, California. The Mare Island Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program of DOE and the Department of the Navy. These activities are being phased out as the Mare Island Naval Shipyard is shutting down.

Middlesex Sampling Plant—Middlesex, New Jersey. The Middlesex Sampling Plant (MSP) is on a 9.6-acre site in north central New Jersey currently used for storage of radioactively contaminated soil. The MSP is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP). The MSP was established in 1943 by the Manhattan Engineer District (MED) to sample, store, and ship uranium, thorium, and beryllium ores. In 1955, the AEC, successor to MED, terminated operations and later used the site for storage and limited sampling of thorium residues. In 1967, AEC activities ceased, onsite structures were decontaminated, and the site was certified for unrestricted use under criteria applicable at that time. Between 1968 and 1980 the site was used by the General Services Administration and then by the Navy as a U.S. Marine Corps training center. In 1980, custody of MSP was returned to DOE, which then began remedial action to clean up vicinity properties.

Mound Plant—Miamisburg, Ohio. Established in 1948, the 306-acre Mound Plant made nonnuclear and tritium components for nuclear weapons, which are assembled at another site. Its other activities include: the separation, purification, and sale of stable isotopes of the noble gases; solar energy research; fossil fuels research; nuclear safeguards; waste management; heat-source testing (plutonium); and fusion fuel systems. Decontamination and decommissioning operations began in 1978 and will continue until FY 2003. Cleanup of all operable units is expected by FY 2015.

Norfolk Naval Shipyard—Portsmouth, Virginia. The Norfolk Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program of DOE and the Department of the Navy.

Palos Forest—Chicago, Illinois. Site A/Plot M at Palos Forest was a reactor site for the Manhattan Project. Two reactors were decommissioned by 1956. Some of the resulting waste was buried at this 20-acre site. Characterization and assessment efforts are currently being performed.

Pearl Harbor Naval Shipyard—Pearl Harbor, Oahu, Hawaii. The Pearl Harbor Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program of DOE and the Department of the Navy.

Pinellas Plant—St. Petersburg/Largo, Florida. The Pinellas Plant, which covers about 99 acres, was established in 1956 to manufacture neutron generators and other electronic and mechanical components of nuclear weapons. In 1993, DOE decided to transfer the missions of the Pinellas Plant to other DOE facilities, and the Pinellas Plant is now shifting to solely a cleanup mission. Interim groundwater cleanup actions are underway. Remediation of a 4.5-acre parcel adjacent to the Pinellas Plant began in FY 1990 and is expected to be completed by FY 1999. The Pinellas Plant sent 3,605 gallons of waste oil in 1978 and 1979 to Peak Oil. Peak Oil used a refining process to purify used oils and lubrication fluids. Mismanagement of waste oil and hazardous waste resulted in extensive soil and groundwater contamination. Pinellas Plant was consequently identified as a Potentially Responsible Party and is partially responsible for cleanup.

Portsmouth Naval Shipyard—Kittery, Maine. The Portsmouth Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program between DOE and the Department of the Navy.

Princeton Plasma Physics Laboratory—Princeton, New Jersey. Located on the Princeton University campus, the Princeton Plasma Physics Laboratory (PPPL) researches magnetic confinement fusion and the practical application of plasma physics. PPPL operates two major magnetic fusion devices, the Tokamak Fusion Test Reactor and the Princeton Beta Experiment-Modification, and a smaller device, the Current Drive Experiment-Upgrade. Remedial actions include characterization of soil and groundwater contamination on the 72-acre site.

Puget Sound Naval Shipyard—Bremerton, Washington. The Puget Sound Naval Shipyard is a U.S. Navy facility that repairs, overhauls, and maintains Navy ships, including nuclear-powered ships. The activities relating to nuclear propulsion systems are performed in accordance with the requirements and authority of the Naval Nuclear Propulsion Program, a joint program between DOE and the Department of the Navy. Puget Sound is the only naval shipyard that removes for safe disposal defueled reactor compartments from decommissioned nuclear submarines.

Reactive Metals, Inc.—Ashtabula, Ohio. Established in 1952, Reactive Metals, Inc. extruded slightly enriched uranium metal for use as a production reactor fuel element. The 60-acre site ceased production in October 1990. Cleanup is being carried out and remediation of buildings and onsite soils is in progress.

Sandia National Laboratories (California)—Livermore, California. The Sandia National Laboratories (California) (SNL-CA) is located on 413 acres next to and south of the LLNL Livermore Site, which is 15 miles due east of Livermore, California. In 1956, SNL established the Livermore facility to provide a closer relationship with LLNL's nuclear weapons research design work. Today LLNL's mission includes laser fusion, laser isotope separation, and biomedical and environmental research, as well as environmental restoration and waste management. Owing to the proximity of SNL-CA to LLNL, the summary descriptions of environmental features presented for LLNL (Section 4.4.6) largely reflect the situation at SNL-CA.

Stanford Linear Accelerator Center (SLAC)—Palo Alto, California. Established in 1962, the Stanford Linear Accelerator Center (SLAC) conducts theoretical and experimental research in high-energy particle physics. It also develops new techniques in high-energy accelerators. SLAC, which is on 426 acres of land, is assessing onsite soil and groundwater contamination from volatile organic compounds and onsite and offsite contamination from polychlorinated biphenyls (PCBs).

University of Missouri—Columbia, Missouri. The University of Missouri is located in Columbia, Missouri. The University is contracted by Rockwell International to conduct experiments to separate radioactive actinide elements from spent fuel using the PUREX process. No experiments have been performed using reactor spent fuel; only pure actinides are present in waste material generated in the experiments. The DOE plans to decontaminate the hot cells to their original condition upon completion of testing. The university also operates the Columbia Research Reactor, a 10-megawatt light-water moderated reactor that uses plate-type fuel containing 93% enriched uranium-235. The university currently stores spent fuel from the reactor in a wet storage facility.

Weldon Spring Remedial Action Project—St. Louis, Missouri. In the 1940s, the Army used the Weldon Spring Site as an ordnance works. In the 1950s and 1960s, the AEC used it for processing uranium and thorium. The site occupies approximately 100 acres, including a 9-acre quarry. Cleanup includes the quarry, a chemical plant, and contaminated groundwater onsite and offsite.

Chapter 4
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CHAPTER 5
Impact Analysis Methodologies

This chapter summarizes the methodologies used to evaluate the potential direct, indirect, and cumulative effects of the 36 Alternatives within the four broad categories of alternatives described in Chapter 3. Following an overview of the waste management impact analysis framework and analytical process, this chapter describes the generic methodologies and assumptions used for waste loads, waste management technologies, and waste management facilities. The chapter then describes how DOE, using generic designs of proposed waste management facilities, derived estimates of facility pollutant discharges to the environment, of resources required or consumed in the process of constructing and operating the facilities, and of costs. The methodologies and assumptions used to evaluate the environmental impacts for each resource area are also explained.

Related discussions of methodologies can be found in other chapters:

Chapter 4 describes the methodology used to characterize the affected environment.

Chapters 6 through 10 describe specific methodologies for the analysis conducted for each of the five waste types.

Chapter 11 describes in more detail the methodologies to estimate cumulative impacts.

Appendix B provides the specific methodology used for the analysis of the sensitivity of waste management (WM) alternative decision making to waste from environmental restoration.

Appendix C provides detailed descriptions of methodologies used to estimate environmental and socioeconomic impacts and cost.

Appendices D, E, and F provide detailed descriptions of methodologies used to estimate human health risks from normal operations, transportation, and facility accidents, respectively.

The technical reports listed in the chapter references provide detailed descriptions of data gathering and estimating methodologies used for each waste type to assess risk, cost, transportation, and accident impacts.

5.1 Overview of the WM PEIS Analysis Approach

5.1.1 IMPACT ANALYSIS FRAMEWORK

In order to evaluate the potential environmental impacts of the alternatives, DOE first identified the type, characteristics, quantity, and special requirements (e.g., handling requirements) of each waste type. The Department then determined the health risks, environmental impacts, and costs of waste management treatment, transport, storage, and disposal as applicable for each waste type. Figure 5.1–1 depicts this framework. To frame the analysis within reasonable bounds and to make the analytical process more manageable, DOE developed and applied particular assumptions. This chapter describes those assumptions and explains the process DOE used to conduct the health risk, environmental impacts, and cost analyses contained in the WM PEIS.

5.1.2 WM PEIS Analytical Process

The treatment, storage, or disposal impacts of alternatives for managing the five waste types were evaluated using an analytical process consisting of three phases, as shown in Figure 5.1–2, for each of the alternatives under the four broad categories of alternatives (No Action, Decentralized, Regionalized, and Centralized).

In the **first phase**, DOE made assumptions regarding waste loads for the five waste types. These assumptions related to the volume of waste currently in inventory and anticipated from future operations of DOE facilities and to its physical (gaseous, liquid, solid), chemical, and radiological characteristics. The assumptions used for each waste type are based on DOE records (see Section 5.2.1) and are described in the waste-type chapters.

DOE also developed a generic design of the waste management processes and facilities that could produce environmental impacts. In developing the generic design, DOE considered all the types of facilities needed to process each waste type (including treatment, transportation, storage, and disposal facilities). The Department also examined the various technologies available for managing the specific waste type and selected one technology option for analysis purposes.[1] The technologies used in the WM PEIS were chosen for analytical purposes only; the Records of Decision based on the WM PEIS will not select technologies.

The generic design of the waste management facility was placed at a specific location on each DOE site—either co-located with existing waste management facilities or at the geographic center of the site—so that actual environmental data from those locations could be used in the analysis of impacts (e.g., data regarding distance to receptors and prevailing winds). It is important to note that the use of a specific location was only to facilitate the computerized analysis of impacts. Decisions regarding the actual location

[1] The facilities considered and the technology chosen for each waste type, and the rationale for that selection, are described more fully in the waste-type chapters.

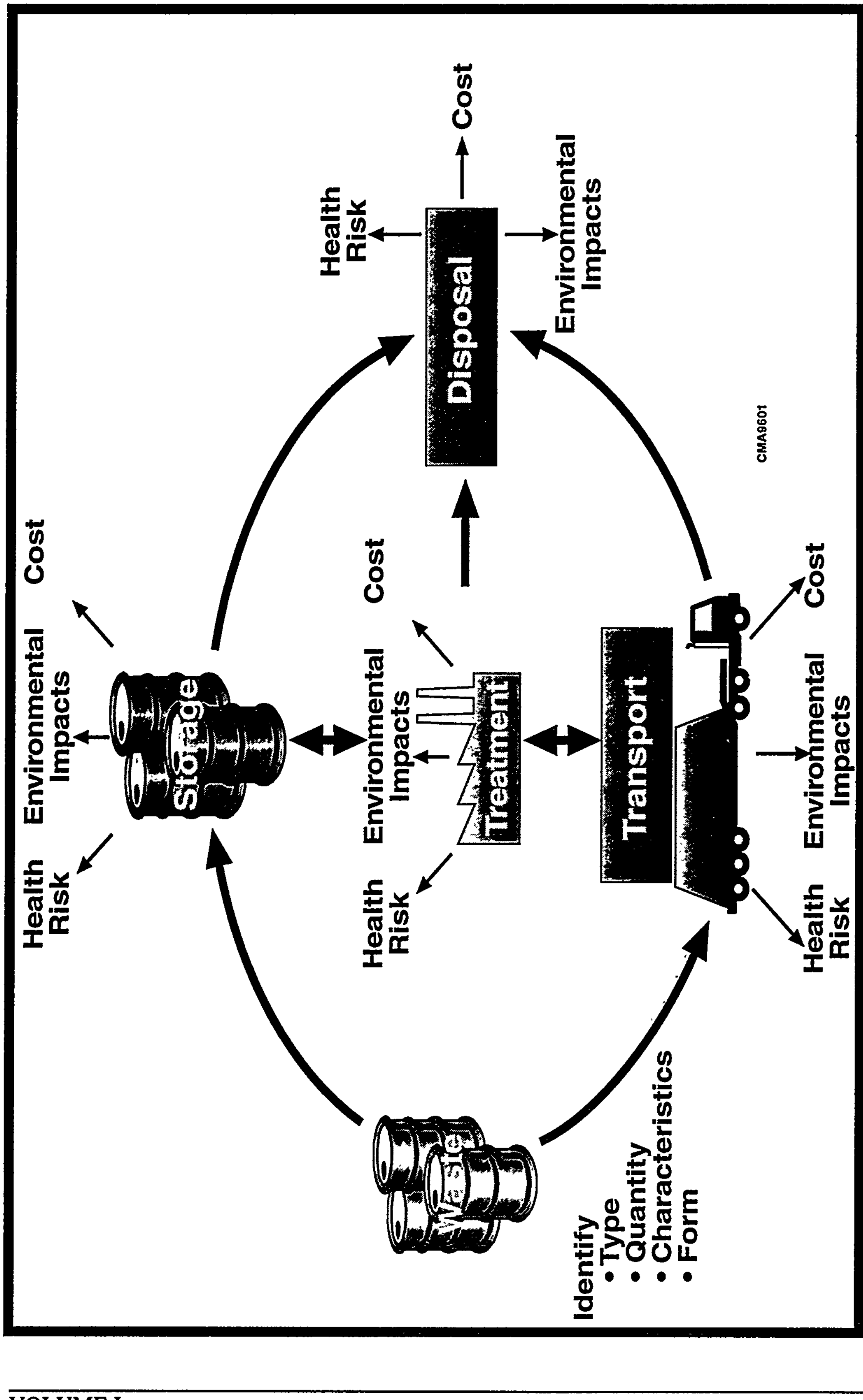

Figure 5.1-1. Waste Management Analysis Overview

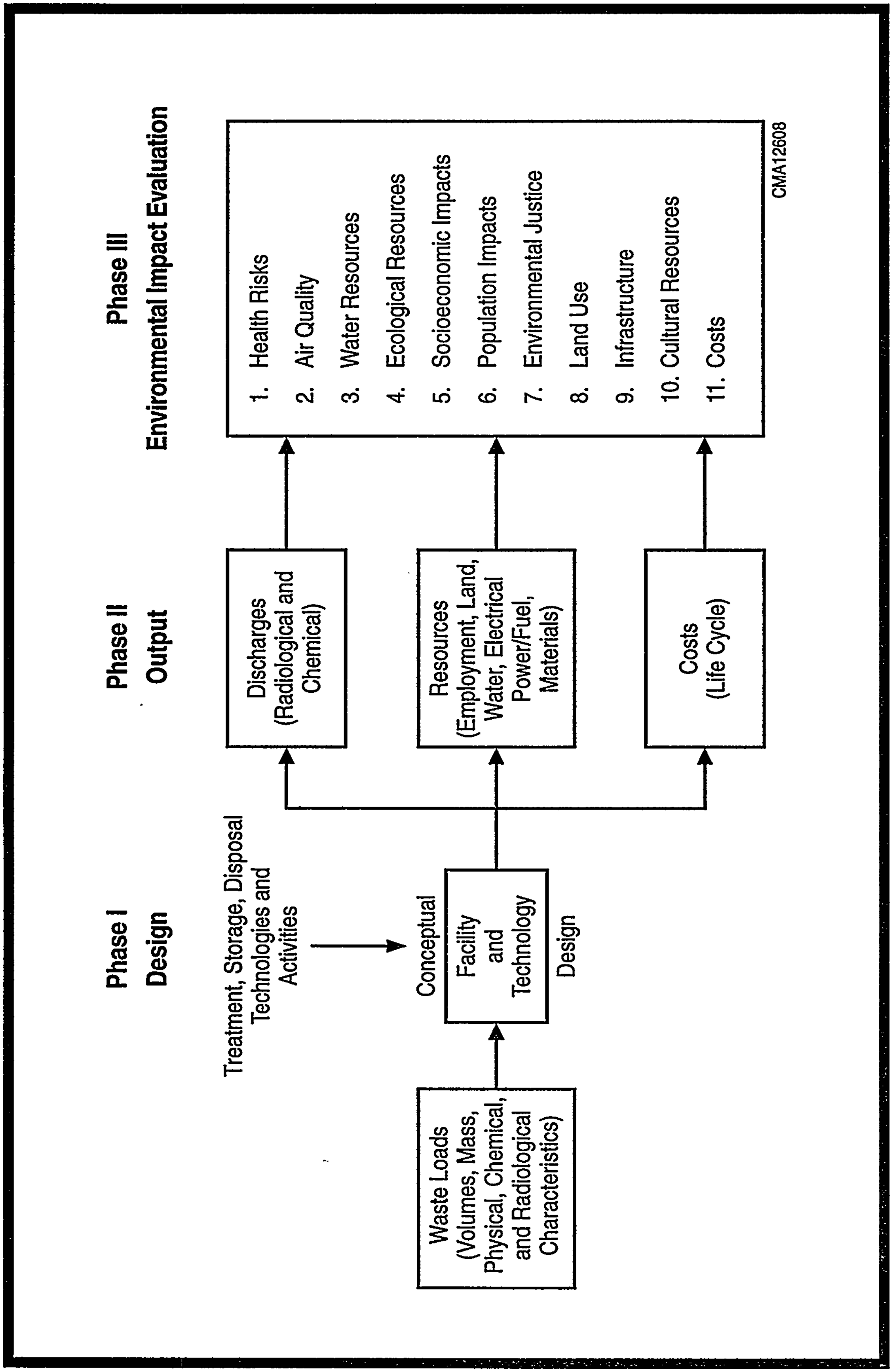

Figure 5.1–2. WM PEIS Analytical Relationships

of waste management facilities at particular DOE sites will not be made on the basis of this PEIS, but rather will be the subject of sitewide or project-specific NEPA reviews. Because locating future WM facilities at the centers of the sites could lead DOE to underestimate impacts at the large sites, where the distance from the center of the site to the site boundary is large, co-locating future WM facilities with existing WM facilities was done at the six largest DOE sites (Hanford, INEL, LANL, NTS, ORR, and SRS). Sections 6.1.3 and 7.1.3 list existing LLMW and LLW disposal facility capacities at these six sites. For the remaining 11 sites, DOE assumed that facilities would be located at the center of each site. Since these are the smaller sites, locating WM facilities at the center of a site would have less mitigative effect on offsite impacts than at the larger sites. Therefore, assuming that facilities would be located at the center of the smaller DOE sites is a reasonable assumption because it is unlikely to drastically affect impact estimates, particularly offsite human health risk.

In the **second phase** of the analytical process, waste materials (using the waste load assumptions developed in the first phase) were conceptually "processed" through the assumed facilities, and estimates of outputs were obtained for radiological and chemical discharges to the environment, the resources required or consumed, and costs. In the **third phase**, the discharges, resources, and costs became the input for evaluating environmental impacts, socioeconomic impacts, and human health risks.

For many aspects of the human health risk and environmental impacts analysis DOE relied on computer models for estimates of discharges and exposures. Table 5.1–1 lists the models used, gives the resource for which they were used, and describes how they were used.

The remainder of this chapter describes the methodologies developed for and used in the three-phase analytical process described above. Information about the generic design phase (waste loads, waste management technology, and waste management facilities) is provided in Section 5.2. Section 5.3 describes the methodology and assumptions used to determine discharges, resources required or consumed, and costs. The methodologies and assumptions used for evaluating the environmental impacts on the various resource areas are described in Section 5.4.

Table 5.1-1. Major Computer Models Used in the WM PEIS

Name	Resource	Developer	Description
MEPAS (Multimedia Environmental Pollutant Assessment System)	Unit dose, risk, and toxicity factors for contaminants related to groundwater	Battelle Pacific Northwest Laboratory	This model simulates the transport of contaminants through the vadose zone and into groundwater to give environmental concentrations of contaminants at various receptor locations.
DUST (Disposal Unit Source Term Model)	Contaminant-specific flux rates out of the disposal facility	Oak Ridge National Laboratory	This model selects unit risks and unit toxicities stored in a data base for specific contaminants in site-facility-, and waste form-specific records.
DITTY (Dose-In-Ten-Thousand-Years, Sub-model of GENII)	Exposure to radionuclides and hazardous chemicals	Battelle Pacific Northwest Laboratory	This model takes the 70-year average concentration, adjusted for humans, and multiplies it by the drinking water populations to give a total contaminant dose, which is multiplied by a slope factor or reference dose to give a unit risk or unit toxicity.
GENII (formerly Generation Model)	Radionuclide unit doses for atmospheric releases	Battelle Pacific Northwest Laboratory	This model simulates the environmental transport of radionuclides released to the environment and predicts the exposure and dose to specified receptors. The model uses an emission rate of 1 Ci/yr (curie per year) for each radionuclide, utilizing a series of Gaussian-plume models to estimate air concentrations.
RADTRAN 4	Population risk along transportation routes	Sandia National Laboratories	This model calculates population risk by scheduling packages through a route, with several input parameters quantifying the loaded vehicle, route, population centers, speed, and stop time.
RISKIND	Consequences of most severe (Category VIII) transportation-related accidents: committed dose, latent cancer fatalities	Argonne National Laboratory	This model calculates consequences for highest potential radiological risk, as identified by screening site-specific characteristics, considering physical forms of waste, and relative hazards of individual radionuclides.
ISC2 (Industrial Source Complex Model, Revision 2)	Hazardous chemical risk and toxicity factors of atmospheric releases	EPA	This model predicts the average concentration in air of chemicals released to the environment which is multiplied by appropriate slope factors and reference doses to give unit risks and unit toxicities.
HIGHWAY 3.1	Truck transportation mileage and routing	ORNL	This model simulates the U.S. highway system, using a least distance and driving time algorithm, including 1990 U.S. Census population densities of centers along routes.
INTERLINE 5.0	Rail transportation mileage and routing	ORNL	This model simulates the U.S. rail system, using a shortest route algorithm, including 1990 U.S. Census population densities of centers along routes.
ALOHA (Areal Locations of Hazardous Atmospheres)	Accidental source term releases (gases)	National Oceanic and Atmospheric Administration	This model uses a dispersion algorithm to simulate continuous and intermittent releases of passive nonbuoyant vapors and heavy gases in rural and urban atmospheres, calculating time-dependent concentrations and hazard distances for various levels of concern.
MicroShield	Unit external dose exposure rate	Grove Engineering (1992)	This model computes the exposure rate for workers within each facility module assuming that a unit concentration of each radionuclide is present.
WASTE_MGMT	Waste loads, radiological and chemical profiles, and emissions	Argonne National Laboratory (1996c)	Using reference files for waste inventory and characterization, TSD facility characterization, and alternative definition, the model quantifies and characterizes waste loads at and emissions from the facilities, and the quantities and characteristics of waste transported among the sites.

Table 5.1-1. Major Computer Models Used in the WM PEIS—Continued

Name	Resource	Developer	Description
MOBILE 5A	Vehicle emissions for criteria air pollutants CO, NO_2 and VOC.	EPA	This model calculates emissions in grams of pollutants per vehicle mile traveled.
PART 5	Vehicle emissions for criteria pollutant PM_{10}	EPA	This model calculates emissions in grams of pollutants per vehicle mile traveled.
RIMS II	Multipliers for disposable income, output and job years for economic impact analysis	U.S. Department of Commerce Bureau of Economic Analysis	This model estimates the response of regional economies to changes in expenditures.
WASTE_ACC	Accident frequencies and radiological profiles of the resulting atmosphere releases	Argonne National Laboratory (1996b)	Using reference filter for accident initiation frequencies, event conditional probabilities, and source term development parameters, the model quantifies the amount of each radioisotope in the atmospheric release and the probability of the release. Interfaced with WASTE_MGMT.

5.1.3 DOE Sites Evaluated

DOE has some waste management responsibility for 54 sites that are within the scope of this PEIS. Of the 54 sites, 17 have been designated major sites in the PEIS because they meet one or more of the following criteria: (1) they are candidates to receive wastes generated offsite, (2) they are candidates to host disposal facilities, (3) they manage HLW, or (4) they were included to be consistent with the Federal Facilities Compliance Act process. The major sites contain the bulk of the five waste types, have the capacity for the future disposal of LLMW or LLW, or have existing or planned major waste management facilities. The WM PEIS analyzes the impacts of waste management activities at these major sites. The designation of these sites as major has no relevance outside of the context of the WM PEIS analysis. Major sites have not been "preselected" for waste management activities; rather, analysis of potential waste management activities at these sites provides a range of environmental impacts that could arise from treating, storing, and disposing of DOE's waste. As a result, broad comparisons of potential impacts across sites can be made.

5.2 Phase I: Reference Design

5.2.1 WASTE LOADS

Waste Volumes. Waste loads reported in Tables 1.6–2 and 1.6–3 in Chapter 1, as well as in Chapters 6 through 10, represent a "snapshot in time"—accurate to the extent existing inventories and future operations were understood when the databases were developed. Accordingly, inventories and projections reported in Table 1.6–3 and Chapters 6 through 10 may not exactly match projections at the time of publication of the Final WM PEIS.

Factors affecting the degree of uncertainty in waste loads can be found in Appendix I, which provides a more recent snapshot of DOE's waste inventory and projections. At selected sites, substantial differences are apparent and represent uncertainties. It was deemed necessary to make only selected updates in the waste load information and associated analyses presented in the WM PEIS. Additionally, as Appendix I shows, consolidation of waste loads and operations across sites in Regionalized and Centralized Alternatives serves to somewhat dampen uncertainty associated with site-specific waste inventories and projections.

Considering these uncertainties, dampening effects, and the selected updates, the waste loads used for the WM PEIS analysis are sufficiently accurate for programmatic decision making. Sources of data for each of the waste types are listed below:

- **Low-level mixed waste (LLMW)**—The *Mixed Waste Inventory Report* (DOE, 1994) was used for all LLMW inventories and generation rates, except for Colonie, ETEC, and RFETS, whose generation rates and inventories come from late 1994 site estimates, and ANL-E and NTS, whose generation rates and inventories come from the updated *Mixed Waste Inventory Report* (DOE, 1995a).
- **Low-level waste (LLW)**—The *Integrated Data Base for 1992* (DOE, 1992) was used for generation rates and inventories of stored waste, except for BNL, NTS, ORR, Pantex, and WVDP, whose generation rates and inventories come from the updated *Integrated Data Base Report–1994* (DOE, 1995b). The Waste Management Information System (ORNL, 1992) was consulted for data not available in the Integrated Data Base.
- **Transuranic Waste (TRUW)**—The *Integrated Data Base for 1992* (DOE, 1992) and the *Interim Mixed Waste Inventory Report* (DOE, 1993a) were used for TRUW inventories and generation rates, except for Hanford and SRS. SRS generation rates and inventories come from the updated *Mixed Waste*

Inventory Summary Report (DOE, 1995a), while Hanford's come from the *WIPP TRUW Baseline Inventory Report (BIR-2) for 1995* (DOE, 1995c).

- **High-level Waste (HLW)**—Site-specific plans and NEPA documents for Hanford, INEL, SRS, and WVDP were used for HLW volume and canister production rates.
- **Hazardous waste (HW)**—The EPA Information System biennial and annual reports (EPA, 1991) were used for generation rates. Offsite shipments to commercial treatment were derived from DOE fiscal year 1992 HW shipping manifests.

With some exceptions, the more recent data in Appendix I include waste projections that are lower than the projections used for analysis by the WM PEIS. This is a reflection of current pollution prevention policies and the reduction in the nuclear weapons mission. The net effect is that the WM PEIS impacts are likely to be conservative, portraying greater impacts than will actually occur. DOE believes that these conservative estimates are adequate for the programmatic purposes of the WM PEIS and that the trends in the WM PEIS are not sensitive to these fluctuations in waste projections. Project-level analyses which would be used to determine actual technology designs and capacities for the waste management activities would rely on the most current data.

It is DOE policy that sites employ pollution prevention practices to reduce the amount of waste generated. The databases from which estimates of annual generation were obtained did not fully consider pollution prevention efforts. Possible impacts of pollution prevention are discussed in Appendix G.

Environmental Restoration Waste. In addition to existing wastes and wastes expected to be generated from the routine operation of DOE facilities (generally referred to as waste management wastes), environmental restoration and decontamination activities at DOE sites will also generate wastes (generally referred to as environmental restoration wastes) that must be further treated or disposed of at waste management facilities.[2] The location and timing of these future environmental restoration activities and the size and characteristics of resulting waste loads are difficult to predict. Thus, the waste loads analyzed in detail in this PEIS do not include wastes that may be generated as a result of environmental restoration activities.

[2] An unknown percentage of environmental restoration wastes will be managed at environmental restoration—not waste management—facilities (see Appendix B). The environmental impacts of managing environmental restoration waste at environmental restoration facilities will be addressed in the Remedial Investigation/Feasibility Studies that DOE conducts under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) for each environmental restoration site.

However, in each of the waste type chapters except HLW and HW, the anticipated environmental restoration waste loads are described for the DOE complex, and compared to the existing and anticipated waste management waste loads. These chapters also contain a discussion of the extent to which the environmental restoration waste loads could affect the comparison of waste management alternatives. There are no HLW loads anticipated from environmental restoration activities. Even though treatment of HLW is not analyzed in this PEIS, the removal of HLW from the tanks at the Hanford Site is considered to be a waste management activity and not a result of environmental restoration activities. DOE anticipates that volumes of HW generated during environmental restoration activities would be treated offsite at commercial facilities. Environmental-restoration HW will not be transferred to waste management facilities.

Physical Structure. While this PEIS covers five waste types, those wastes are not homogenous and are derived from thousands of different waste streams. Thus, the waste streams were combined into treatability groups for purposes of developing treatment system designs. Each treatability group is identified with one of the five waste types considered in the WM PEIS and a treatment method, where appropriate, that EPA recognizes as meeting the requirements of RCRA. For the WM PEIS analyses, the physical structure of the waste was used for the initial sort for treatability. At the most basic level of analysis, all waste can be grouped into six physical categories using common engineering criteria design parameters, which also served as the initial set of treatability categories:

- **Aqueous liquids**—Primarily water with organic content less than 1% (such as process wastewater)
- **Organic liquids**—Liquids and slurries with organic content greater than 1% (such as solvents)
- **Organic and inorganic sludge and particulates**—Solid and semisolid material other than debris (such as sludge from treatment plants, resins, and solids less than 2.5-inch diameter particle size)
- **Soils**—Contaminated soils
- **Debris**—Solid material exceeding 2.5-inch diameter particle size that is either (1) manufactured, or (2) plant or animal matter, or (3) discarded natural or geological material (such as cobblestones)
- **Other**—Special waste streams (such as batteries, laboratory packs, reactive metals, and toxic metals, which include mercury, lead, and beryllium)

Four waste types use this basic framework analysis: LLMW, LLW, TRUW, and HW. For purposes of the WM PEIS analysis, HLW, also in the above treatability categories, is assumed to have been treated (vitrified). The HLW analysis only addresses the environmental consequences of storing and transporting vitrified HLW canisters. The environmental impacts of HLW treatment are addressed in other DOE NEPA documents identified in Section 9.1 and are included in the cumulative impacts addressed in this PEIS in Chapter 11.

Radiological and Chemical Composition. The DOE used standard radiological profiles for each site and made assumptions about the concentration of each waste type in each treatability group based on available data on the origins of the waste. Hazardous constituents were apportioned to the treatability groups on the basis of the most prevalent hazardous chemicals using average compositions for all DOE sites. The assumptions for both radioactive and hazardous elements are waste-type specific and are summarized in more detail in the waste-type chapters. Details of the radiological and chemical compositions assumed for each waste-type are found in the respective technical report published for that waste type. See the reference lists for titles.

The standard profiles supported the evaluation of risks from waste disposal to the hypothetical farm family and impacts to groundwater quality for the most prevalent radionuclides and hazardous constituents in DOE wastes. Impacts were not evaluated for many radionuclides and hazardous constituents not present in significant quantities, because the databases on which the WM PEIS is based, in most cases, do not contain sufficient information on the presence of these constituents. Adverse impacts could occur from some of these small quantity constituents. In addition, one radionuclide that is contained in the standard profile used when the actual characterization of the waste is not known, carbon-14, was not included in the evaluation of impacts from disposal of LLW or LLMW. Carbon-14 would be expected to move relatively quickly through the groundwater, and has a moderately long half-life (approximately 5,730 years). Therefore, health risk and groundwater quality could be adversely affected if significant quantities of this radionuclide were present in the waste. However, including this radionuclide without specific knowledge of its existence or concentration at a site would have biased the analysis results without scientific foundation for the assumption of its presence. Adverse impacts from the presence of specific radionuclides or hazardous constituents could be mitigated by additional treatment and/or instituting waste acceptance criteria at the disposal facility. The impacts of these trace quantity constituents could be considered in more detail in sitewide or project-specific NEPA documents, if necessary.

5.2.2 Waste Management Technologies

Various waste management technologies are used to sort and handle waste, reduce waste volume, destroy organic chemicals in waste, remove toxic metals from waste, treat hazardous characteristics to render them nonhazardous, recover and recycle materials, and stabilize and package waste for disposal. The facilities that use these technologies must be designed to accommodate the various physical and chemical forms and the radioactive and chemical characteristics discussed in previous sections. Existing, generic technologies necessary to meet the treatment, storage, and disposal requirements for each waste type were identified and sized to meet anticipated waste volume needs. Existing, rather than advanced, technologies were used because the applicability of advanced technologies is more problematic, because estimates of environmental impacts would more likely be conservative (tending to be the highest likely to occur) with the use of existing technologies, and because the type of technology would be unlikely to determine the preferred alternative. However, advanced technologies could be considered in project-specific NEPA reviews expected to tier from this programmatic review.

For analytical purposes, and to facilitate utilization in any system at any site, the waste management technologies were grouped into **common functions** (front-end support such as administrative and laboratory services; receiving, inspecting, dumping, and sorting the waste; maintenance of facilities; certification and shipping of the waste), **pretreatment** (shredding and compaction), **primary treatment** (thermal destruction, special processing, neutralization, deactivation, aqueous waste treatment, lead recovery, mercury separation and recovery), **secondary treatment and stabilization** (polymer stabilization, grout stabilization, packaging, and vitrification of secondary processing residues), **storage** (administration, receiving and inspection, contact-handled storage, and remote-handled silo storage), and **disposal** (administration, receiving and inspection, shallow land disposal, engineered vault disposal, silo disposal, and borehole disposal).

5.2.3 Waste Management Facilities

Treatment, transportation, storage, and disposal "modules" were developed to represent every component required for waste management. Each module was assumed to contain several types of equipment, each able to perform a step needed in the waste management process.

Individual modules were linked together for each treatability group and were adjusted for the chemical and physical type of waste. This method was used so that impacts could be compared among sites, with each site assumed to be using the identical array of linked modules. Any variation in impacts would then result from site-specific environmental differences. This approach also allowed an examination of the changes in impacts resulting from changes in the linked modules.

Typically the type of facility considered was a building structure, i.e., a "fixed" facility at a given site. The analysis also considered the possible use of mobile treatment facilities that could be moved from site to site for treatment of the very small amounts of waste that exist at a number of the sites considered.

The generic design of the waste management facility, consisting of these treatment, storage, transportation, and disposal modules, enabled the calculation of land utilization, worker-years, resource consumption (i.e., water and electricity), pollutant discharges, and costs for the treatment, storage, transportation, and disposal of each waste type. The engineering features of the generic facility and the waste loads "processed" through the generic facility formed the basis for the risk and environmental impacts analysis.

For purposes of analysis, the following assumptions were made regarding the construction and operation of the waste management facilities:

- The facilities were assumed to be built over a 10-year period and operated over a 10-year period to process wastes generated over the 20-year construction and operation period. It was assumed that existing waste management facilities did not operate (i.e., did not process waste) during the 10-year construction period for new facilities. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for HLW storage facilities, which are discussed in Chapter 9 in Volume I of the WM PEIS. The WM PEIS analysis is highly conceptual, and DOE recognizes that construction of actual facilities could occur within a much shorter time period and that waste will begin to be processed at some facilities before construction at all facilities is completed. Nevertheless, DOE believes that the WM PEIS provides a reasonable and conservative estimate of environmental impacts sufficient to support programmatic decision making.
- For new facilities, the costs of decontamination and demolition were included; for disposal facilities, the costs of custodial care after closure through a 300-year period of institutional control were included, but were not substantial.
- The facilities were assumed to operate 240 days per year with three 8-hour shifts.

Although the WM PEIS analyzes the environmental impacts from the operation of the WM facilities for only 10 years, it is possible that the facilities could operate for up to 30 years. During this additional 20-year operating period, additional WM wastes or ER wastes could be processed. DOE believes that most of the impacts of operating the WM facilities for an additional 20 years would be similar, on an annual basis, to the impacts of operating these facilities for the 10 years analyzed in the WM PEIS. DOE believes this for the following reasons:

- The 10-year period of operations analyzed in the WM PEIS includes processing any wastes in storage, wastes accumulated during 10 years of construction, and wastes generated during the 10 years of operations. Therefore, the annual feed rate into the WM facilities would be expected to be higher or comparable to the feed rate during the latter 20 years of operations.
- Many of the impacts analyzed in the WM PEIS were analyzed on a daily or annual basis. For example, infrastructure impacts were analyzed for resource use in gallons of water per day, gallons of wastewater per day, and megawatts of power per year. Resource use during operation of the facilities for an additional 20 years is unlikely to exceed these annual rates of resources use and therefore is unlikely to exceed the environmental impacts predicted in the WM PEIS.
- Some impacts in the WM PEIS, such as human health risk to the offsite population, were analyzed for the entire 10-year operations period. DOE expects that the impacts during the additional 20 years of operations would be no more that twice the impacts predicted in the WM PEIS. For example, if the WM PEIS predicted a population health risk of 1 in 1 million (see Chapters 6 through 11 for actual health risk estimates), the additional health risk of operating the facilities for 20 more years would be no more than 2 in 1 million, with total health risk for 30 years of operations of 3 in 1 million.

This analysis assumes that the characteristics of the waste processed during the additional 20-year operating period are similar to the characteristics of the wastes analyzed in the WM PEIS. If the characteristics of the wastes processed during the latter 20 years of operations are found in the future to be appreciably different from the characteristics of the waste analyzed in the WM PEIS, additional environmental documentation could be prepared to support continued operations.

5.3 Phase II: Output

5.3.1 Discharges

As noted above, using a generic design of a waste management facility (including treatment, storage, transportation, and disposal modules) and hypothetically processing wastes through that generic design, DOE derived estimates of pollutant discharges. DOE assumed the existence of discharges as a result not only of the radiological and chemical components of the waste, but also from the burning of fuel to operate the waste management facility.

5.3.2 Resources Required or Consumed

The resources required to process wastes (e.g., workers, land, water, electrical power, and raw materials) were based on estimates for the materials, labor, and other resources needed to build, operate, and maintain the waste management facilities. The resources were identified and added in the estimating process, and became input to the impacts analyses. Resource estimates were developed for the construction and operations and maintenance phases. The industrial engineering analysis established the number of workers for each type and size of facility module.

5.3.3 Costs

The costs evaluated were life-cycle costs of facilities plus transportation costs between sites. Facility costs include the costs of: planning, design, construction, operations and maintenance (O&M), and decontamination. The total costs of each alternative include the sum of the treatment, storage, disposal, and transportation costs, and, in some instances, any special costs where specialized treatment (other than treatment specified in generic design modules) is now being performed and will continue to be performed in the same manner in the future. Each alternative includes a definition of the assumed technologies for the complete treatment process. For each site and each alternative, wastes were hypothetically routed through the waste management process, and the modules were individually sized to handle the processing requirements. Since many sites have some existing treatment, storage, and disposal capabilities, the analysis accounts for existing facilities to minimize additional construction requirements. Only the O&M and decontamination costs were estimated for those existing facilities (INEL, 1996).

The transportation methodology tables (for LLMW, LLW, TRUW, and HW) include summaries of fixed and variable costs for each intersite transportation route segment and were computed for road and rail options. Each fixed cost component equals the number of trips multiplied by a fixed cost waste-type trip price. Each variable cost component equals total mileage transported by route segment, multiplied by a waste-type cost-per-mile price. The number of trips reflects the amount of waste divided by the capacity of individual trucks or railcars. Weight and volume restrictions were considered, and the mileage for each trip was derived from current DOE guidelines. Trip prices and cost-per-mile prices were established by reviewing transportation industry tariffs and practices (INEL, 1995b). Transportation costs for HLW were computed using regression formulas developed by ANL from industry practices (ANL, 1996a).

Costs are presented in constant dollars, reflecting the total life-cycle costs by waste-type alternative. Costs were estimated using an approach that tied the cost of facilities and transportation to waste quantities. In addition, DOE used costs associated with existing technologies and historical industrial cost experience for estimating purposes.

The program life-cycle cost estimates for the various WM PEIS alternatives include the following major cost elements:

- **Preoperations costs**—technology site adaptation, including bench tests and demonstrations; statutory and regulatory permitting; plant startup costs; and related generic design, project management, and contingencies
- **Facility construction costs**—building, equipment, and related design; construction management, project management, and contingencies
- **Operations and maintenance costs**—annual operations, maintenance, utilities, contractor supervision and overhead, and related project management and contingencies
- **Decontamination and decommissioning costs**—demolition of facilities, environmental closure, postclosure, and monitoring activities
- **Transportation costs**—intersite road and rail transportation carrier costs for the transportation network established by Department of Transportation computer models (INEL, 1995b)

The cost elements also include the following subelements: direct labor, equipment, and materials; indirect technical labor and facilities; overhead and profit; government administration and management; and reserve/contingencies. The cost elements do not include site infrastructure costs, operations office oversight costs, or DOE program and policy-related costs.

The waste management process modules costs were developed for a range of facility waste processing capacity. The cost estimates for each module size (small, medium, large) were then used as data points linking waste load throughput to cost. For very small waste loads, mobile units or skid-mounted units were used. These units use existing structures and utility connections (INEL, 1995a, c-e).

Preoperations costs were estimated by including factored costs for generic design, safety assurance studies, project management and contingencies; extracting costs for bench tests, demonstrations, and permitting requirements from management analysis studies; and including the operations and maintenance costs for 1 year to allow for test production runs and operational certification; the preoperational monitoring requirements (DOE Order 5400.1, Chapter IV, Section 3) were also included.

Construction costs were estimated for each module, sized for large, medium, and small operations. This procedure involved laying out the waste management process line and contacting industrial suppliers about prices for the equipment used; determining the size and nature of the building required to house the process line; computing building costs using standard construction estimating procedures; and factoring in all other elements that constitute the remainder of the construction cost element (INEL, 1995a,c-e).

Operations and maintenance costs were estimated by extracting annual costs for operations labor, material, and utilities from management analysis studies; by considering maintenance labor and material costs from equipment purchase and site costs; and by including costs for contractor supervision and overhead, project management, and contingencies.

Decontamination costs were estimated by multiplying the area of the facility by a unit cost based on square footage established through cost studies, addressing different waste-type facilities separately (INEL, 1995a,c-e).

The cost analysis provides data that should fall within $\pm 30\%$ of actual costs using the waste loads quantified in the alternatives. This range reflects the experience of the cost estimators using similar procedures (based on standard design costing procedures) for other generic design industrial processes and DOE projects. Changes in the characterization and quantity of the waste loads would significantly affect costs. Indirect costs and overhead burden rates used in the cost estimating methodology were based on those historically encountered at DOE's Idaho National Engineering Laboratory (INEL). They fall approximately in the middle of the range of cost factors found at several other DOE sites and were therefore considered to be representative for complexwide estimating purposes.

Facility costs were established on the basis of the costs of DOE facilities (primarily at INEL) and commercial facilities. To the extent possible, equipment costs for each facility module were compared with data from existing facilities to establish a cost confidence level with the boundaries established for programmatic life-cycle cost estimates. Both DOE and the commercial nuclear industry are now planning or operating similar facilities. These facilities were surveyed to obtain capacity and cost data, and other information needed to support the cost methodology data. Before using these costs, the data were adjusted to account for capacity differences and escalation.

Additional assessment activities included a review of existing DOE facility capital and operating costs for comparison with the cost methodology data. Existing DOE facilities that have been evaluated include the Waste Experimental Reduction Facility (incineration, shredding, and compaction) at INEL; the Controlled Air Incinerator at Los Alamos National Laboratory; the Toxic Substances Control Act (TSCA) Incinerator at the Oak Ridge Reservation; the Supercompactor and Repackaging Facility at Rocky Flats; the Radioactive Waste Management Complex (LLW disposal) at INEL; and the Transportable Waste Water Treatment Unit from the Uranium Mill Tailings Remedial Action Project. Planned DOE facility costs at INEL were also evaluated for the Radioactive Waste Storage Facility, the Waste Characterization Facility, the Idaho Waste Processing Facility, and the Mixed Low-Level Waste Treatment Facility.

Other facilities evaluated include the Illinois Compact Low-Level Engineered Disposal Facility and the Commonwealth of Massachusetts Low-Level Radioactive Waste Disposal Facility.

Cost estimates for facility components were adapted from commercial sources (INEL, 1995b-d, 1996). Commercial facilities evaluated include conceptual designs and cost estimates for the following: air- and area-monitoring units from Eberline Corporation of Santa Fe, NM; amalgam mixers from Miracle Paint Rejuvenator of St. Paul, MN; blending equipment from Velmac Associates, Inc., of Novato, CA; calciner/kiln units from ABB Raymond, Inc., of Lisle, IL; chemical oxidation units from Peroxidation

System, Inc., of Tucson, AZ; compactor units from Stock Equipment Company of Chagrin Falls, OH; concentrator units from LCI Corporation of Charlotte, NC; drum capping and washing units from Stock Equipment Company of Chagrin Falls, OH; dry offgas filters from Pall Advances Separation Systems of Cortland, NY; dry and wet offgas treatment trains from NGK-Locke, Inc., and Callidus Technologies; drying equipment from Wyssmont, Co., Inc., of Fort Lee, NJ; extruder equipment from Sterling Extruders, Davis-Standard Division of Edison, NJ; gross-organic removal units from McTighe Industries, Inc., of Mitchell, SD; incineration packages from Joy Energy Systems of Charlotte, NC, and ABB Raymond, Inc., of Lisle, IL; quencher and scrubber (wet scrubbing) units from Croll-Reynold Company of Westfield, NJ; melter units from Ajax Corporation and Retec Corporation; preparation and feed units from various vendor quotes; processing equipment from the U.S. Navy LLW processing facility of Lynchburg, VA; open dump, and sort devices, and robotic arms in consultation with personnel from DOE contractors involved with the Office of Technology Development, Robotic Technology Development Program; organic stripper units from APV Crepaco, Inc., of Tonwanda, NY; radiological and hazardous material measurement systems from conceptual designs and cost estimates provided by Lockheed Martin; segmented gamma scanning (SGS) assay systems data from Atlan-Tech Corporation, Inc., of Roswell, GA; shredder units from Komor Industries, Inc., of Groveport, OH; feeder/shredder units from System Service Solutions of Wilsonville, OH; retort units from Denver Mineral Engineers, Inc., of Littleton, CO; size reduction and baler systems from Stock Equipment Company of Chagrin Falls, OH; selected solidification units from Stock Equipment Company; solidification module assemblies from Stock Equipment Company; stack monitoring units from Eberline Corporation of Santa Fe, NM; suspended-solids filtration systems (Membralox) from U.S. Filter Corporation of Warrendale, PA; thin film evaporator units from LCI Corporation of Charlotte, NC; washing equipment from CF Systems (a subsidiary of Morrisen-Knudson); wet oxidation units from Zimpro of Rothchild, WI; and the commercial treatment and disposal processes for hazardous wastes from various vendors (INEL, 1995a-d).

5.4 Phase III: Environmental Impact Evaluation

The environmental impact assessment methodologies and assumptions described in this section address the range of natural and human resource issues pertinent to the range of alternatives under consideration in this PEIS. The following sections provide the scientific approach and analytical methods used to evaluate potential environmental consequences (including health risks), as presented in the subsequent waste-type Chapters 6 through 10.

The generic design and estimated waste loads provided the output data for the impact assessments. The estimated discharges of pollutants to air and water as a result of the treatment, transportation, storage, and disposal of the five waste types were used to calculate human health risks. Combustion by-products discharged to the air from waste treatment facilities were not considered in the health risk assessments conducted for most waste types because the potential impacts from exposure to these contaminants are expected to be minor compared with impacts from releases of radionuclides and hazardous chemicals occurring in the wastes. However, emissions of dioxin and furan from hazardous waste treatment facilities were considered in the health risk analysis conducted for LLMW and HW. The results of the health risk analysis are presented in Sections 6.4 and 10.4 of this volume. The health risk analysis also included evaluation of the potential impacts of waste transportation. Impacts from transportation included estimation of excess latent cancer fatalities resulting from exposure to diesel exhaust (see Appendix E for additional details).

The air quality analysis for O&M considered emissions of criteria pollutants from incineration and from combustion to provide heat for buildings. Emissions of these pollutants were compared with applicable air quality standards to determine compliance. The standards are set, in part, through consideration of adverse health effects. Therefore, health effects of combustion by-products were also indirectly considered in the air quality analysis in the WM PEIS.

Risks to the public and workers from facility treatment, storage, and disposal operations, for both routine and accident conditions, used information on waste characteristics and worker-years. Wastes transported to other sites for treatment or disposal were evaluated for the radiological, chemical, and physical risks they pose to the public and to workers for both routine and accident conditions (for rail and truck transport).

For comparison purposes, environmental concentrations of pollutants are presented in this PEIS with the appropriate regulatory standards or guidelines. For all resource areas, an effort was made in this PEIS to use data that were as current as possible.

All exposures to chemical and radiological discharges were estimated using computer models that simulate the fate and transport of contaminants in the environment.

Use of Percentages in Analysis and Presentation of Environmental Impacts. In summary, DOE used a three-step process to evaluate environmental impacts: (1) preparing comprehensive estimates of all impacts, (2) screening these impacts and focusing the analysis on those with a greater potential to be significant, and (3) preparing a summary listing and description of potentially significant impacts.

First, DOE estimated environmental impacts at major DOE sites for each alternative and each waste type. The site data tables in Volume II of the WM PEIS list the results of this comprehensive analysis without any screening for significance. Because of the volume of data and because NEPA requires agencies to focus on significant impacts, DOE made the tables a separate part of the document and did not insert them in Volume I. DOE screened the table values and further evaluated those with a potential for significance in the PEIS text (Chapters 6 through 10).

Use of Percentages where Regulatory Standards Exist. In assessing impacts on resources for which regulatory standards or guidelines exist, DOE evaluated the significance of waste management facility pollutant emissions and effluents by comparing facility emission and effluent estimates or resultant concentrations to relevant Federal and state regulatory limits. DOE based its evaluation of the significance of impacts on the environmental and socioeconomic resources that have no such comparable regulatory standards, on significance criteria defined in CEQ regulations of 40 CFR 1508.26 and on the experience and judgment of the WM PEIS interdisciplinary team members in their fields of expertise.

Air Quality Impacts. The air quality impacts presentation focused on sites and alternatives where air quality standards could be exceeded (that is, where air quality impacts could be significant). Thus, all cases where emissions are 100% of a standard or greater are presented in the waste type chapters. In addition, DOE chose a 10%-of-standard threshold to highlight the sites where air pollutant emissions from proposed waste management activities do not exceed standards, but where they could substantially contribute to overall pollutant emissions from all sources in the area, which could result in cumulative air quality impacts.

Water Quality Impacts. For the groundwater quality impacts analyses for low-level mixed waste and low-level waste, estimates of pollutant concentrations in downgradient well water caused by disposal facility leachate were compared to relevant water quality comparison criteria. As was the case for air quality, all sites/alternatives where the comparison criteria are met or exceeded are presented in the waste type chapters because they represent a potential for significant impacts to persons consuming the groundwater. In addition, to account for some level of uncertainty in the modeling results for the disposal analysis, water pollutant concentrations that met or exceeded 25% of the comparison criteria are also presented in the waste type chapters for discussion, even though they would be less likely to indicate instances where impacts would be significant.

Economic and Population Impacts. For economic and population impacts, DOE used a 1% significance screening level because regional economic or population changes of 1% or more in the communities around DOE sites are likely to be considered by those communities as substantial; that is, economic benefits are likely to be important and population growth could substantially affect social and medical services, housing, and educational systems. This is particularly true if the economic or population changes occur in localities within an affected region rather than uniformly across the region.

Ecological Resources and Land Use Impacts. For ecological resources and land use impacts, DOE used a screening level of 1%, principally to screen out sites under an alternative where DOE can reasonably conclude it is unlikely there would be significant impacts. DOE based this percentage on the fact that it has not yet proposed facility locations and detailed impact evaluation would require location-specific information and that, at sites where less than 1% of the available land would be required for waste management facility construction, DOE would have sufficient flexibility to locate the facility in a manner that would avoid significant impacts to critical habitats and site land use.

Infrastructure Impacts. The analysis of infrastructure impacts was somewhat more complex. For the impacts analysis of the onsite water, power, and wastewater treatment infrastructure, DOE discusses requirements that exceed 5% of current capacities in Chapters 6 through 10. DOE believes that, in general, infrastructure requirements below 5% could be accommodated by existing infrastructure because estimates of capacity would have some built-in margin for substantial peak loads. Corresponding capacities of onsite transportation infrastructure were not known, so DOE estimated increases in site employment as an index of the potential increased traffic load on existing site transportation infrastructure. DOE discussed site employment increases of 5% or more as instances in which transportation infrastructure impacts from those increased traffic loads could be significant. Similarly, offsite infrastructure impacts were keyed to regional population growth, with growth greater than 5% considered to have the potential to cause substantial stress to the regional transportation infrastructure.

For both the standards-based and nonstandards-based analyses, it must be emphasized that:

- All impacts were analyzed consistently; that is, the impact values were estimated for each major site using the same input data and computations for all alternatives.

- All impacts estimates are provided in the WM PEIS in the site data tables.
- Screening values were used to focus the waste-type chapter presentations on impacts with a greater potential to be significant, thereby minimizing discussion of those likely not to be significant.
- Screening values were not used and should not be interpreted as "absolute" benchmarks of the significance or nonsignificance of an impact, but only as indicators of the importance or extent of impacts resulting from particular alternatives.

Use of Percentages in Defining the Affected Environment. Other screening criteria were used to focus the impacts analysis on those components of the environment likely to experience significant impacts. For example, the region-of-influence (ROI) for socioeconomic impacts was defined as encompassing the DOE site host county and nearby counties which, in combination, were the residence counties of at least 90% of the site's current employees (DOE, 1993c). The rationale for use of this percentage is that it would identify those counties where most of the project expenditures would be made, particularly for locally available materials, such as concrete, where the major portion of the workers' salaries would most likely be spent, and where workers would be most likely to move, which in turn would affect housing, community service, and financial infrastructure.

5.4.1 Human Health Impacts

The human health risk analysis provides estimates of the adverse effects, or impacts, on human health that might occur as a result of implementation of the proposed waste management actions. Risks resulting from facility routine operations and accidents and waste transportation were estimated in the WM PEIS.

Risks to the public and workers from facility treatment, storage, and disposal operations, for both routine operation and accident conditions, were derived using information on waste loads (volumes and characteristics) and required worker-years. Wastes transported to other sites for treatment or disposal were evaluated for the radiological, chemical, and physical risks they pose to the public and crews for both incident-free and accident conditions (for both rail and truck transport).

The approach taken in the WM PEIS risk analysis was first to identify the groups potentially at risk and then to compare the risk that these groups (and individuals within them) may sustain if the different alternatives were implemented. Each phase of waste management activities—treatment, storage, and disposal—included in an alternative was considered when identifying the persons at risk, the exposures that produce that risk, and the types of health impacts that the exposed groups might experience. As discussed in Appendix F (Section F.2.3.4), incineration was selected as the treatment technology most likely to dominate risk to site workers and to the surrounding populations, and accordingly was used as the reference technology for accident calculations.

The risk assessments conducted for the WM PEIS used assumptions and best-estimates when data were only generally known or where processes have not been demonstrated fully; therefore, uncertainties are present. Additional details about the methodologies and assumptions used to assess human health impacts can be found in Appendices D, E, and F.

5.4.1.1 Uncertainty in Risk Estimates

Human health risk assessment results are conditional estimates that are influenced to a large extent by the many assumptions that must be made in order to account for an insufficient understanding of biological processes or a lack of information on contaminant or receptor behavior. Therefore, in evaluating risk estimate results, it is important to recognize that uncertainties are involved in the analysis in order to place the risk estimates in proper perspective.

Risk estimates are composed of a number of parameters. To estimate risk, information must be available on dose/response relationships which define the biological response per unit of exposure to a contaminant. Although human epidemiological data are used for developing radiation dose-response models, dose-response data are also developed in laboratory tests using animals exposed to relatively high doses. Therefore, uncertainty in dose/response relationships includes extrapolating from effects in animals seen at high doses in order to estimate potential effects in humans that most often are exposed at lower doses.

Another important component of risk assessment is estimation of exposure concentrations. Uncertainties associated with this component of the analysis include estimating (generally through the use of mathematical models) releases of contaminants from emission sources to different environmental media, the transport and transformation of contaminants in these media, and the pathways, frequency and duration by which humans contact the contaminants. Modeling involves trying to simulate a process that is inherently complex using a fixed and relatively small number of variables. Model uncertainty may result from the general limitations of mathematical models as well as from the lack of information on model parameters. For example, the fate and transport models used to estimate risks for the WM PEIS require large amounts of data, including meteorological measurements, hydrogeologic settings, and release parameters. Where possible, actual data are used, but generic data are often substituted where site-specific data are unavailable.

The assumptions made in performing this program-level evaluation were intended to yield reasonably conservative risk estimates (e.g., estimates that tend to overestimate rather than underestimate risk) using the best available data and state-of-the-art models. Many of the uncertainties associated with the WM PEIS risk estimates are "systemic," given the programmatic nature of the WM PEIS and the use of the unit approach to risk assessment. This means that many of the modeling and scenario assumptions (e.g., facility emission rates for particular types of waste treatment or storage, inhalation rates, etc.) were applied consistently or systematically throughout the analysis. Therefore, the *relative* differences in risk estimates among waste management alternatives should not be affected by errors associated with these systematic uncertainties.

The uncertainties associated with the WM PEIS risk estimates cannot easily be quantitatively evaluated because of the many different parameters involved in the models used in the analysis. However, risk estimate uncertainty can be qualitatively differentiated as follows. Certain risks, such as worker physical hazard injuries during construction, or transportation accident physical trauma injuries, are based on historical statistics or actuarial data (e.g., number of hours worked, or number of miles traveled). Therefore, these risks can be estimated with a relatively high degree of confidence.

On the other hand, risks associated with the release of radionuclides or chemicals to ambient environmental media during the routine operation of treatment or storage facilities are estimated using probabilistic models. The risk estimates produced by these models have a larger uncertainty than those based on actuarial data. However, it is reasonable to assume that such releases will occur on a routine basis over the operational lifetime of the facility; that is, the estimated annual frequency (or probability) of occurrence of these events is one.

A third group of risk estimates generally involve even more uncertainty than facility routine operation exposure risks. This group includes facility accident risks and the hypothetical farm family and intruder scenarios. These risk estimates also involve the use of probabilistic models. However, unlike releases from facilities during routine operations, facility accidents generally have estimated probabilities of occurrence that are much less than one. Therefore, in interpreting the potential risks from facility accidents, both the estimated probability of occurrence as well as the estimated consequences should be considered. Certain low probability accidents (e.g., aircraft crashes) may have potentially large consequences (e.g., a large number of latent cancer fatalities), but they are not expected to occur very often (e.g., probability of less than one-in-one million on an annual basis). Other types of accidents (e.g., fires) may have a higher probability of occurrence (e.g., one-in-one hundred) but generally have smaller consequences.

The hypothetical farm family risk estimates include an additional degree of uncertainty, since they attempt to estimate risks far into the future (up to 10,000 years). Both the hypothetical farm family and intruder scenarios take place in the future and assume the loss of institutional control of disposal facilities allowing the establishment of a farming operation that uses groundwater near the disposal site and excavation directly into the disposal unit.

Finally, the maximally exposed individual (MEI) risk estimates generally involve a greater level of uncertainty than population risk estimates, given the required assumptions about continuous exposure at a specific location for a single individual.

Appendix D, Section D.4, presents an evaluation of some parameter uncertainties associated with the WM PEIS health risk estimates.

Similar to the facility risk discussed above, the determination of transportation risk is subject to numerous uncertainties. Whereas risks such as physical injuries and fatalities from transportation accidents are based on historical statistical data, radiological risks are predicted using complex mathematical models. These models attempt to describe transportation operations that take place over time and through a constantly changing landscape. Moreover, different models and assumptions are typically used to describe different shipment modes, such as truck and rail, and may result in different levels of uncertainty between modes. Additional details related to the uncertainties in transportation risk estimates, including considerations in comparing truck and rail shipment results, are provided in Appendix E.

5.4.1.2 Populations and Individuals at Risk

Several groups may be exposed to a variety of hazards during the treatment, storage, and disposal phases of waste management. In general, the WM PEIS considers:

- The offsite population—those living within a 50-mile radius of the site, as well as within 0.5 miles on each side of the transportation routes
- The onsite population—the workers on DOE sites who are not involved in actual environmental management activities (the "noninvolved" or "collocated" workers)
- The facility workers (or "waste management workers," including those operating the trucks and trains that transport the waste)

The WM PEIS health risk analysis evaluates impacts to members of the public living within a 50-mile radius of DOE sites, to waste management workers, and to onsite workers not directly involved in the proposed waste management actions. For each of these groups of receptors, the standard risk assessment assumption of 70 years is used for the length of an average lifetime.

For offsite population receptors, health risks are primarily from exposure to airborne contaminants released from waste treatment facilities. Both radionuclide and hazardous chemical contaminants are potentially released. Exposure to radionuclides and hazardous chemicals is assumed to occur over the 10-year period of facility operation. Exceptions to this assumption would include a full 20-year operations phase (i.e., construction phase not applicable) for the No Action Alternative, and the site-specific operational periods for HLW storage facilities, which are discussed in Chapter 9. Exposure to radionuclides that are inhaled or ingested is expected to continue for up to 50 years, since these contaminants, once incorporated into the body, will irradiate tissues even after the 10-year operation period has ended. This 50-year exposure period (also known as a commitment period) is assumed for radionuclide releases from both treatment facilities and from trucks or railcars following transportation accidents.

Waste management workers are also subject to physical hazard injuries and fatalities resulting from industrial accidents occurring during the assumed 10-year facility construction period and 10-year facility operation period.

Population risks are expressed as numbers of cancer incidences, cancer fatalities, or genetic effects. Individual risk was assessed by considering the hypothetical MEI within each onsite and offsite population. These persons would receive the highest total dose—estimated by summing the highest doses delivered along all pathways over the person's lifetime. Risks for individuals are expressed in probabilities that a particular adverse effect will occur (ORNL, 1995a,b). DOE has not specifically evaluated the human health risk to subpopulations that may derive a substantial portion of their food supply from native plants and animals that live near DOE sites. This is a complex analysis that cannot be performed with confidence until locations of the facilities on the sites are known, the routes of exposure explicitly defined, and the dietary habits of the populations quantified.

5.4.1.2.1 *Intruder Scenario*

To consider the maximum potential human exposure from the disposal of waste, the WM PEIS examines scenarios of a hypothetical intruder and a hypothetical farm family.

An intruder scenario was evaluated in order to estimate the potential health risks to an individual from the disposal of LLW and LLMW in a future era when disposal facilities are no longer under institutional control. A hypothetical intrusion scenario with two different time frames (100 and 300 years after closure of the disposal facility) was developed. The scenario assumes that a single adult drills a well directly through the disposal facility to the water table. As a result of the drilling, contaminated soil from within the facility is brought to the surface, where it mixes with the top layers of the surface soil. The individual raises crops on this plot of land and consumes the resulting produce.

Exposure of the intruder to radionuclide and chemical contaminants was assumed to result from the ingestion of plants, inhalation of resuspended soil particulates, and inadvertent ingestion of soil. In addition, the intruder was assumed to be exposed to direct radiation from the soil. Health effect endpoints evaluated as a result of radionuclide and direct radiation exposure included probability of cancer fatality, cancer incidence, and genetic effects. For chemical exposure, the endpoints used were probability of cancer incidence and noncancer risks.

5.4.1.2.2 *Hypothetical Farm Family*

The hypothetical farm family is assumed to establish a water supply well 300 meters downgradient from the center of an underground disposal facility. This distance is roughly equivalent to the 100-meter distance from the edge of the disposal unit used in the performance assessment analyses required under DOE Order 5820.2A. Concentrations of groundwater contaminants at this location are assumed to be higher than those that could be expected at greater distances from the unit due to dispersion of contaminants. Construction of multiple units is expected to be required at certain sites, particularly under the Regionalized and Centralized Alternatives in order to process the projected waste volumes. Since the analysis looks only at a single receptor located 300 meters from the center of each unit, DOE assumes that each of these close-in receptors will be affected primarily by the contaminant plume from the disposal unit closest to them. DOE recognizes that commingling of contaminant plumes from multiple disposal units may occur as distance from the units increases, but anticipates that, at 300 meters, the highest concentration of contaminants is likely to result from the single closest plume. At greater distances from the disposal units, where overlap of the plumes is more likely, the concentrations in any given plume should be lower than those estimated at the 300 meters well as a result of dispersion and dilution. The WM PEIS did not address groundwater contaminant concentrations at distances greater than 300 meters from disposal units. More detailed analyses, such as the performance assessments required under DOE Order 5820.2A, will address the issues of existing groundwater contamination and multiple disposal units. For example, in April 1996 DOE issued guidance for the conduct of composite analyses in addition to performance assessments to help ensure that continuing disposal of low-level waste will not compromise the future radiological protection of the public. The composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from an active or planned LLW disposal facility and other sources of radioactive material in the ground that might interact with the LLW disposal facility.

The hypothetical farm family scenario assumes that a series of families lives downgradient of the disposal unit for a period of 10,000 years. Each family's lifetime is assumed to be of 70 years' duration; therefore, 143 lifetimes were evaluated. The exposure to this hypothetical farm family was assumed to occur at a time when there has been a breach of the disposal facility and when institutional controls (fences, warning signs, land records, etc.) no longer exist. The family engages in farming activities, such as growing and consuming their own crops and livestock, and uses nearby water for drinking, bathing, and recreation as well as for watering their crops and livestock. This hypothetical farm family is assumed to be located so that they received the highest possible exposure to contaminants in groundwater by all possible routes. The 10,000-year period was selected for the analysis to maintain consistency with the "Guidelines for Radiological Performance Assessment of DOE Low-Level Radioactive Waste Disposal Sites" that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessments has since been changed; current guidance suggests that a 1,000-year time period should be used in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A.

The hypothetical farm family scenario attempts to estimate potential risk resulting from the future contamination of groundwater following disposal of LLW and LLMW. Humans are assumed to be exposed through use of the groundwater as a source of drinking water and irrigation water. Several aspects of the scenario should be noted. The analysis addresses only new disposal units and does not account for existing disposal inventory or existing groundwater contamination at a site. Also, this analysis does not attempt to suggest that farming is a reasonable or preferred future use of the land at DOE sites upon the loss of institutional control. Farming was selected only in order to maximize the potential exposure and risk from contaminated groundwater through its use both as drinking water and in crop irrigation at arid sites.

5.4.1.2.3 *Collective Offsite Population*

The population risk vulnerability analysis was developed to compare LLMW and LLW disposal alternatives using measures that characterize their relative potential to cause disposal risks to offsite populations.

Rationale for Not Quantifying Offsite Population Risks From Disposal. The hypothetical farm family scenario does not attempt to quantitatively estimate the potential risks to current offsite populations living near DOE sites (collective risks) from the disposal of LLMW and LLW. Certain considerations led DOE to conclude that an alternative to collective risk estimation was needed for the WM PEIS comparison of disposal alternatives. First, other DOE efforts to address disposal risk do not generally estimate population risk. DOE has been addressing the issue of protecting the public from the effects of exposures to radioactive and mixed waste constituents released from disposal facilities. Ongoing Department efforts include performance assessments conducted for LLW disposal facilities in compliance with the requirements of DOE Order 5820.2A and performance evaluations conducted for candidate LLMW disposal sites by the FFCAct Disposal Workgroup. Although these efforts currently address risks to single individuals at specified compliance points, none attempts to predict collective risks to current or future populations.

Second, DOE determined that estimation of offsite population risk from exposure to disposal facility contaminants in the WM PEIS would require too many speculative assumptions and would not provide a credible basis for comparison of LLMW or LLW disposal alternatives. The concentrations of contaminants in the groundwater and the number of people potentially exposed will be determined in large part by the locations of the disposal units and the receptor wells. Estimation of the number of adverse health effects in current offsite populations would require information about the exact locations of the disposal facilities on sites. Since the WM PEIS does not attempt to make such siting decisions, offsite population doses (i.e., person-rem) and risks (e.g., number of latent cancer fatalities) from disposal were not estimated. Analysis of future offsite population risks requires similar siting information and involves additional uncertainty with respect to the sizes of future populations. Therefore, the WM PEIS could not credibly estimate adverse health impacts from disposal for future offsite populations.

Given this uncertainty about quantifying potential collective risks to offsite populations from waste disposal, DOE determined that some relative indicator of the potential for offsite risks would be an appropriate approach. Therefore, DOE has supplemented the quantitative estimates of farm family MEI risk presented in Sections 6.4 and 7.4 of Chapters 6 and 7 with statistical analyses of site environmental data. These analyses evaluate site parameters that influence groundwater contamination or that are expected to be associated with the sizes of the populations potentially at risk. The results of the analyses are indicative of the relative potential for offsite population risk from disposal. This procedure is a screening- level analysis that does not take into account any measures that would limit migration of disposed wastes into the groundwater, such as engineered disposal units or changes in waste acceptance criteria. The objective of the analysis is not to rule out any sites for disposal—a number of sites are currently disposing LLW—but to indicate where disposal mitigation measures are more likely to be necessary and where the costs of disposal would likely increase as a result of such measures.

Population Risk Vulnerability Analysis Approach. In the population risk vulnerability analysis, DOE selected environmental variables expected to determine or be associated with the level of offsite population risk, performed statistical factor and cluster analyses to determine how to group the sites in terms of vulnerability, then tabulated the individual site and overall alternative vulnerability classification of the LLMW and LLW disposal alternatives.

Selection of Important Explanatory Variables. The variables chosen to be used in the factor and cluster analyses of the 16 candidate disposal sites were six site characteristics that would likely cause or be associated with future levels of offsite population risk from radioactive or mixed waste disposal—annual rainfall, annual groundwater recharge, aquifer depth, travel time of water from the time it infiltrates the ground surface to the time it reaches the aquifer and appears in a downgradient well, current human populations within 50 miles of the site, and site acreage (see Table 5.4–1). The first three variables, which characterize the surface and groundwater hydrology of the sites, are measures known to influence the speed, duration, and extent of dispersal of contaminants from disposal facilities, and the level of resulting downgradient concentrations in groundwater. The travel time estimates are based on the physical properties of the soils, the aquifer depth, and the groundwater velocity at each site. Current population levels are considered the most appropriate measure of the potential size of the population at risk, at least on a relative basis from site to site. It should be noted that the parameter "current population level within 50 miles" serves only as a general index of potential populations at risk from contaminated groundwater, not as a specific estimate of future populations at risk. The 50-mile radius populations may include large, relatively distant population centers (such as Buffalo in the case of WVDP) that would not likely draw groundwater from downgradient wells or, on the other hand, may exclude large population centers just outside the 50-mile radius (such as Las Vegas in the case of NTS) that may use downgradient wells in the future. Site acreage provides an indirect measure of two associated characteristics—the size of the potential populations at risk and the likelihood that contaminants in downgradient groundwater would appear in a publicly accessible wellwater source, the former because the larger sites exclude population growth on extensive areas, the latter because of the relationship between the proximity of offsite population centers to locations on the sites where disposal facilities likely would be constructed.

These site characteristics are generally strongly correlated with each other—for example, the smaller sites tend to be situated in regions of denser population with higher rainfall. Therefore, DOE transformed the 96 data points comprising the six variable measures on the 16 sites mathematically, using a statistical technique called factor analysis, into principal factor variables that are composite measures of the important variations in these site characteristics. Factor analysis reconstitutes the data into a smaller derivative set of "explanatory variables" as linear combinations of the original variable set (Norusis/SPSS Inc., 1993). Appendix C, Section C.4.1 provides the details of the factor analysis methodology. In this analysis, 80% of information in the data set is represented after the factor transformations by two principal factors. The first factor, which accounts for approximately 64% of the variability in the site environmental data, is primarily a positive measure of the site rainfall and recharge characteristics and a negative measure of groundwater travel time. The second factor, accounting for an additional 15% of the data variability, is primarily a measure of the sites' size and population characteristics. The sites are arrayed according to their scores on the first two principal factors of the site environmental data in Figure 5.4–1. Sites to the right in the diagram have higher scores on the first factor, indicating they have groundwater hydrologic conditions

Table 5.4-1 Environmental and Population Data Used to Categorize Disposal Sites in Terms of Population Risk Vulnerability

Site	Population Within 50 Miles	Acreage	Annual Rainfall (cm)	Aquifer Depth (ft)	Annual Aquifer Recharge (ft/yr)	Time of Travel (yr)
ANL-E	7,939,785	1,025	80	90	0.33	246
BNL	5,738,554	5,263	107	200	0.50	59
FEMP	2,764,589	1,050	104	59	0.50	18
Hanford	377,645	370,656	16	236	0.16	191
INEL	153,061	572,160	23	600	0.23	298
LLNL	6,324,234	6,900	36	98	0.08	70
LANL	159,152	28,000	47	749	0.05	411
NTS	14,266	864,000	19	787	<0.001	1,352
ORR	895,379	34,560	139	26	0.60	11
PGDP	500,502	3,425	120	49	0.43	17
Pantex	265,185	16,000	51	320	0.02	175
PORTS	639,062	4,032	101	24	0.39	24
RFETS	2,171,877	6,550	38	18	0.16	25
SNL	610,714	2,791	20	94	0.06	132
SRS	620,618	192,700	122	110	1.30	23
WVDP	1,698,391	220	104	10	0.23	226

that would tend to move contaminants more quickly downgradient from disposal units and possibly to drinking-water wells that might be used by the public. Sites to the left in the diagram are those where site characteristics would tend to limit migration of contaminants and increase the time over which any movement might result in wellwater contamination. In terms of scores on the second factor, sites plotted in the upper portion of the diagram are those that are smaller in size with higher surrounding populations. Those plotted lower are the larger sites with lower surrounding populations. Land uses on and near the sites, the site size itself, and the size of the surrounding populations are more likely to change substantially during the time contaminants may be leaching from disposal units than the physical characteristics of the site. Therefore, DOE considers the first factor scores more important than the second factor scores in characterizing the sites' relative potentials for offsite population risk.

Derivation of Population Risk Potential Groups. The factor analysis gives a general indication of the relative population risk vulnerability of the 16 proposed disposal sites. The factor scores of the 16 sites show relationships among the sites in hydrologic and population characteristics that would be reasonable

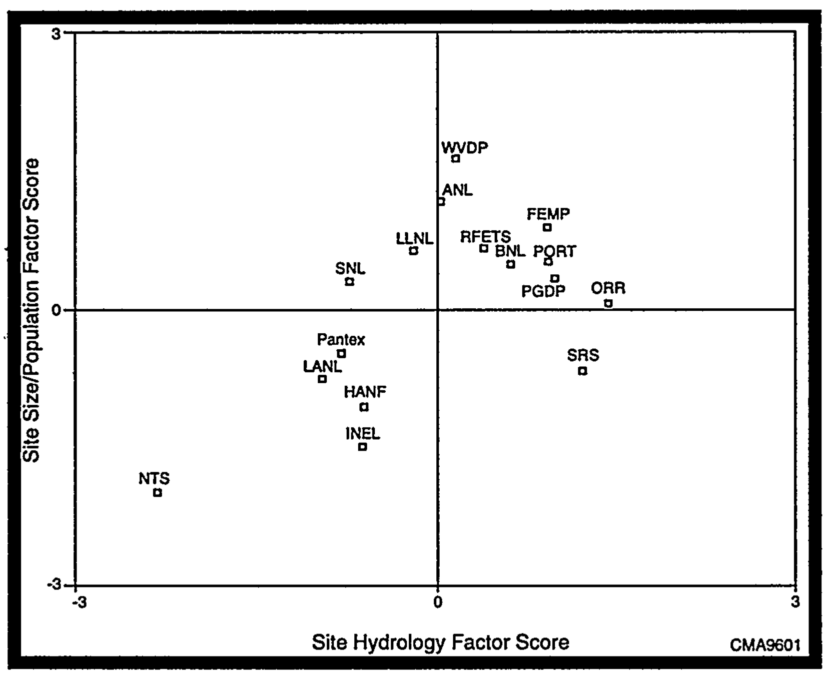

Figure 5.4–1. Sites Arrayed According to Their Scores on the First Two Principal Factors of Environmental Data

to conclude would be directly related to the levels of population doses and risk. DOE proceeded further to identify distinct groups of sites representing similar levels of potential for population risk from waste disposal using a cluster analysis of the same six site characteristics.

In the cluster analysis, DOE used the site environmental data on the six variables to calculate measures of overall difference among the 16 sites. These difference measures were used to combine sites into clusters. The difference measures are greater between clusters than they are for sites within a cluster. By labeling the factor plots with the cluster membership of each site, distinct risk vulnerability groupings were identified. Details of the cluster analysis for the 16 proposed disposal sites are presented in Appendix C.

The cluster analysis was used to identify three general site groups according to their expected relative population risk vulnerability (PRV). The group number of each site is plotted against the two principal factors of the site data in Figure 5.4–2. The groups are listed with the basis of their relative population risk vulnerability ratings in Table 5.4–2.

Population risk vulnerability was judged to increase from left to right in the factor diagram (Figure 5.4–2). Group 3 sites were judged to have a relatively higher offsite population risk vulnerability for waste disposal (Table 5.4–2) because these sites scored highest on the first environmental factor—and those scores are expected to be directly related to the level of eventual leaching of contaminants from the LLMW or LLW disposal facilities and the rate of transport of contaminants through the groundwater. Group 1 sites were considered to have a relatively lower population risk vulnerability because their scores on both factors are lower than the other site clusters. Group 2 sites generally scored high on the population/site size factor but lower than Group 3 sites on the groundwater hydrology factor. Because the first factor is considered a more important determinant, they are considered intermediate in terms of population risk vulnerability.

5.4.1.2.4 *Comparison of Alternatives for Population Risk Potential*

LLMW and LLW disposal alternatives were arrayed in terms of greater or lesser potential for population risk based on the final PRV group designation of the sites proposed for disposal under each alternative and the waste volume, total radioactivity, and number.of disposal units proposed under each alternative at each of the sites. LLMW and LLW alternatives were then summarized in terms of the total waste volume, total

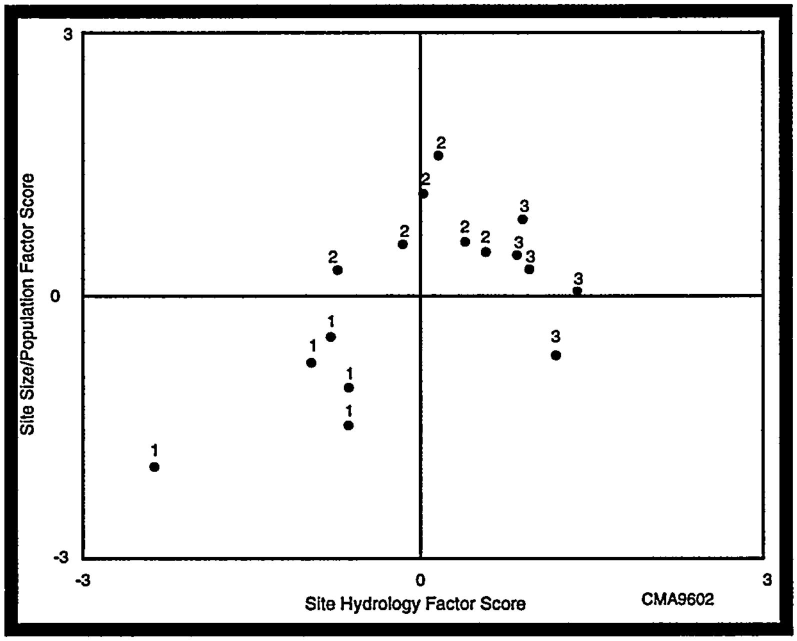

Figure 5.4–2. Sites Labeled by Population Risk Vulnerability Group Number Arrayed According to First Two Principal Factors of Environmental Data

Table 5.4–2. Population Risk Vulnerability Groups of the 16 Proposed Disposal Sites

Population Risk Vulnerability Group	Relative Offsite Population Risk Level	Sites in Population Risk Vulnerability Group	Relative Score on Groundwater Hydrology Factor	Relative Score on Site Size/Population Factor
3	Higher Relative Risk	FEMP, PGDP, PORTS, ORR, SRS	High	Intermediate to High
2	Intermediate Risk	ANL, BNL, LLNL, RFETS, SNL, WVDP	Intermediate	Intermediate to High
1	Lower Relative Risk	HANF, INEL, LANL, NTS, Pantex	Very Low to Low	Very Low to Intermediate

radioactivity, and number of disposal units required at all sites within each population risk vulnerability group. Those alternatives with greater volume, total radioactivity, and number of disposal units at PRV Group 3 sites could generally be considered to represent a relatively greater risk to populations than alternatives that concentrate disposed wastes at PRV Group 1 and 2 sites. From a population risk perspective, alternatives that concentrate disposed wastes at PRV Group 1 sites would represent the lowest potential risk.

5.4.1.3 Exposure Pathways

Different groups were assumed to be exposed through different pathways during each waste management phase. The exposure pathways and potentially affected populations and individuals are summarized in Table 5.4–3. The exposure pathways considered for the different receptor groups are shown in Figures 5.4–3 through 5.4–6. The exposure pathway for storage was assumed to be direct radiation from the storage containers.

The potential exists for human exposure to radiological and chemical contaminants in surface water. Receptors can be exposed through the use of contaminated surface water for drinking water, bathing, swimming, or irrigation. In addition, ingestion of fish or shellfish taken from contaminated surface waters may be another source of exposure through bioaccumulation of the contaminants in the tissues of these organisms. Potential pathways for surface water contamination from waste management practices include deposition of contaminants released to the atmosphere to surface water bodies, overland runoff to surface waters, releases of contaminants in aqueous effluents from treatment and storage facilities, and recharge of surface waters by groundwaters potentially contaminated through waste disposal.

A limited analysis was performed to show the potential health effects from the deposition of airborne contaminants on surface water bodies. Preliminary estimates described in Appendix D for the Columbia and Clinch Rivers indicated that the potential dose received from ingestion of surface water contaminated by deposition of airborne contaminants was a thousand to millions of times lower than that received from inhalation in a gaseous plume of hazardous or radioactive material. Other potential pathways of surface water contamination can be controlled or are more affected by the technical design and relative location of the waste management facilities with respect to the location of surface water bodies. Releases of contaminants in aqueous effluents from treatment and storage facilities are expected to be small because

Table 5.4-3. Exposure Pathways for Treatment, Storage, Transportation, and Disposal Activities

Waste Processing Phase	Pathway	Potentially Exposed Populations and Individuals
Treatment • Routine emissions • Accidents	Atmospheric • Inhalation • Ingestion of crops and animals[a] Direct radiation	• Public within 50-mile radius • Onsite employees, evenly distributed within site borders (atmospheric only) • Onsite MEI (atmospheric only) • Offsite MEI (atmospheric only) • Waste management worker (inhalation and direct radiation only)
Storage • Routine emissions • Accidents	Atmospheric • Inhalation • Ingestion of crops and animals Direct radiation	• Public within 50-mile radius • Onsite employees, evenly distributed within site borders (atmospheric only) • Onsite MEI (atmospheric only) • Offsite MEI (atmospheric only) • Waste management worker (inhalation and direct radiation only)
Disposal • Routine emissions	Atmospheric • Inhalation Groundwater • Ingestion of drinking water • Irrigation of crops • Watering of livestock • Bathing Direct radiation	• Waste management worker (atmospheric and direct radiation during disposal operations only) • Hypothetical farm family (ingestion of groundwater and food) • Hypothetical intruder (ingestion of crops and soil, inhalation of soil particulates, direct radiation)
Transportation ◦ Routine emissions ◦ Direct radiation ◦ Accidents	Atmospheric (accident only) ◦ Inhalation ◦ Ingestion of crops and animals[a] Direct radiation	• Population living and traveling along the route and present at rest stops • Workers

Note: MEI = maximally exposed individual.
[a] Radiological only.

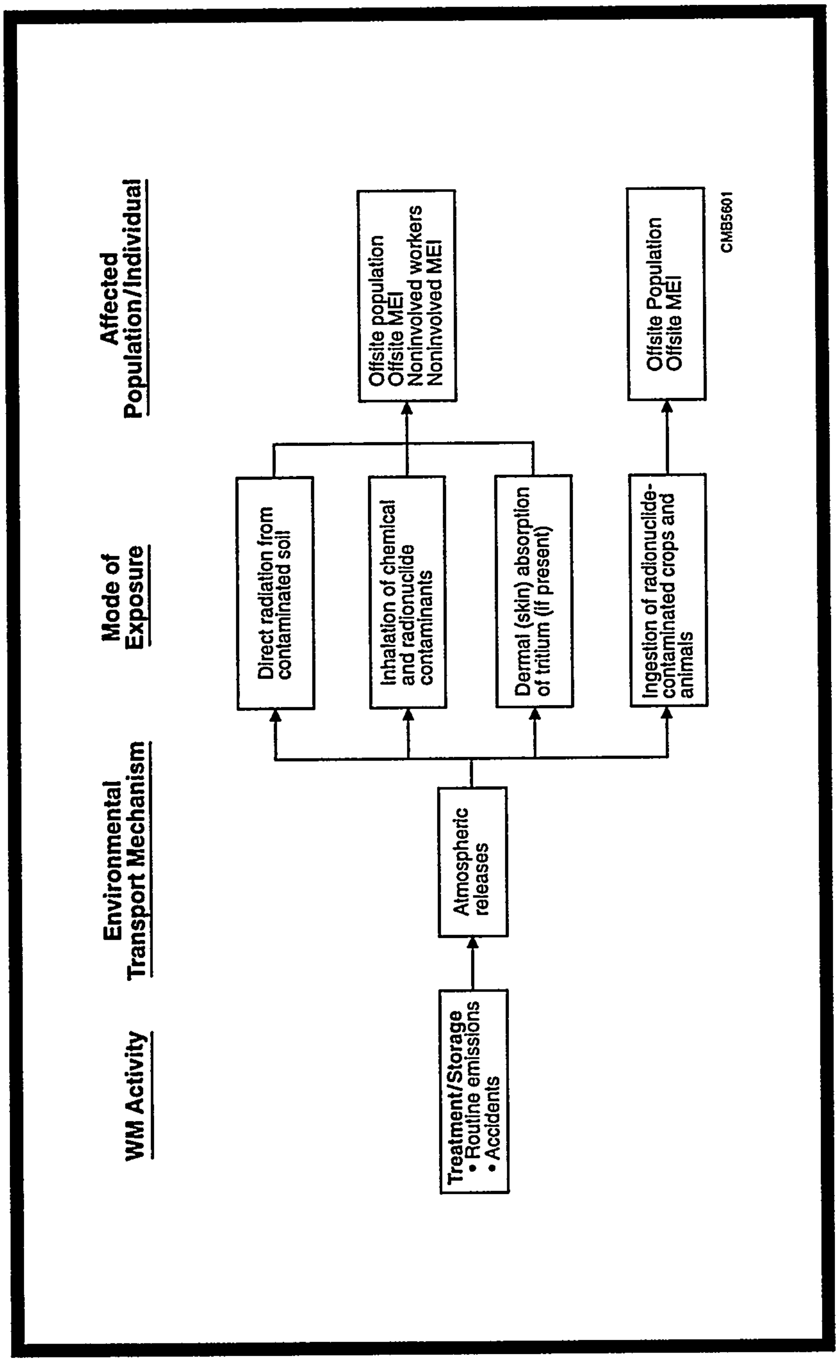

Figure 5.4-3. Exposure Pathways for the Offsite and Noninvolved Worker Populations for Treatment and Storage Activities

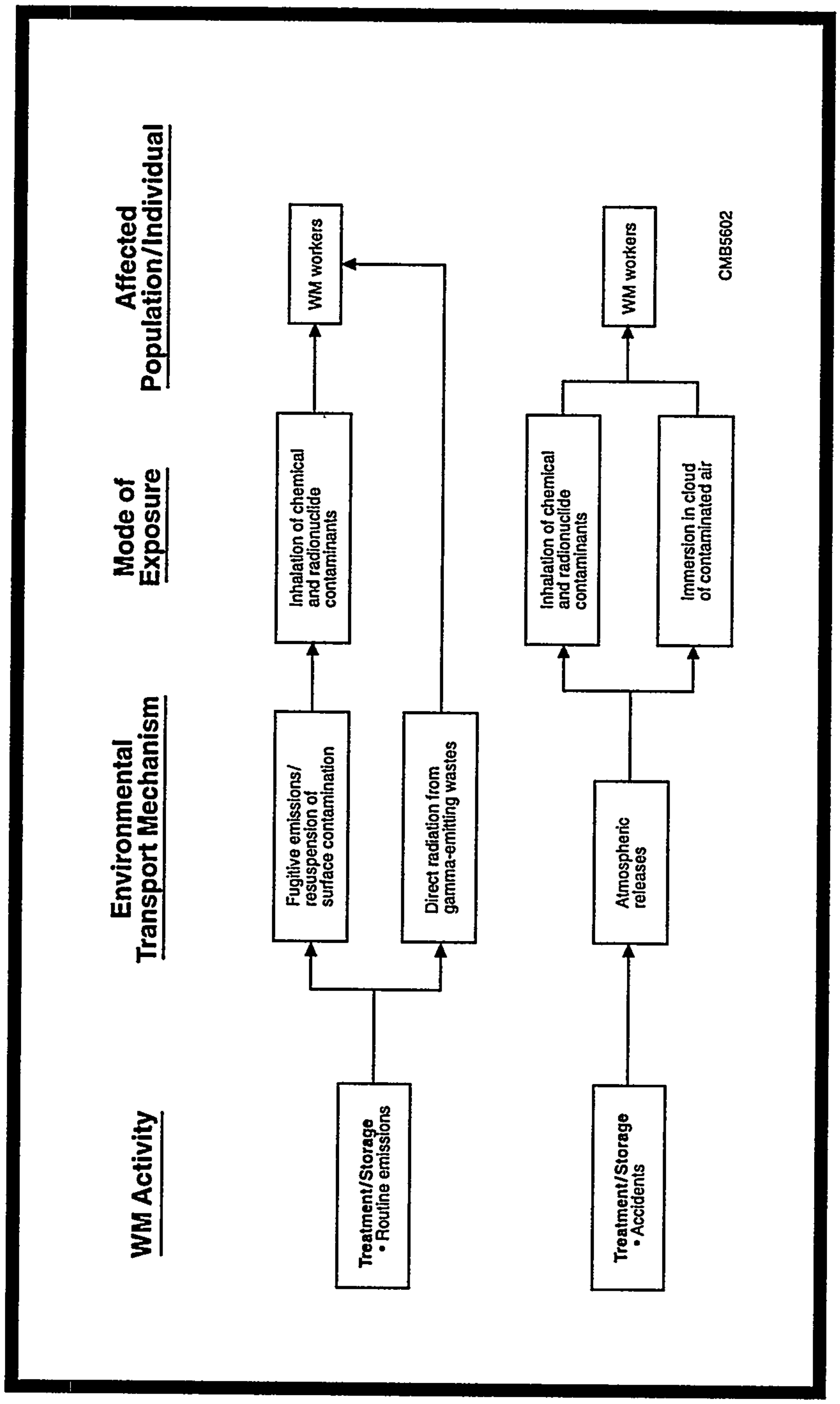

Figure 5.4–4. Exposure Pathways for Waste Management Workers for Routine Operations and Accidents During Waste Treatment and Storage

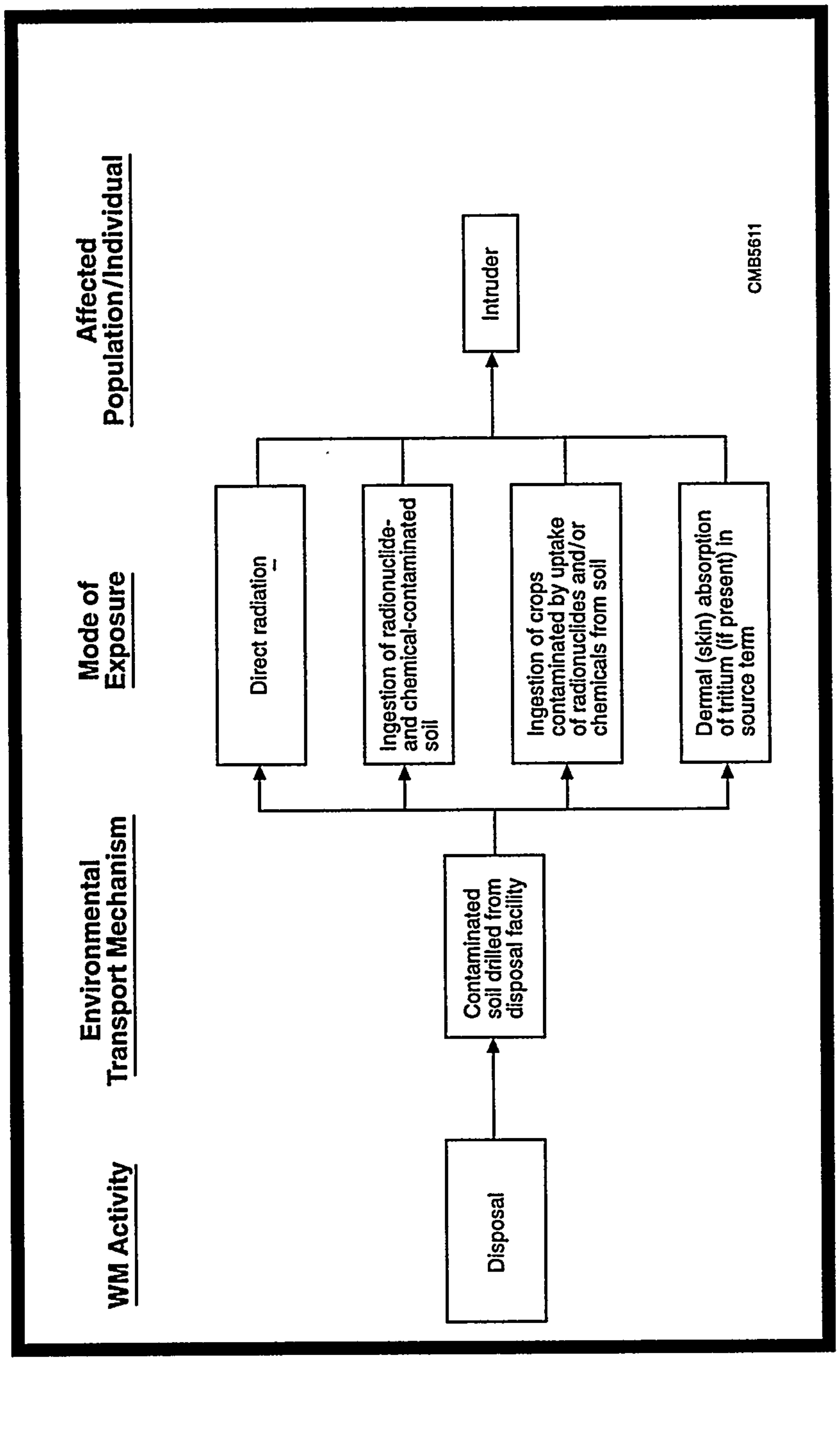

Figure 5.4–5. Exposure Pathways for the Intruder for Disposal Activities

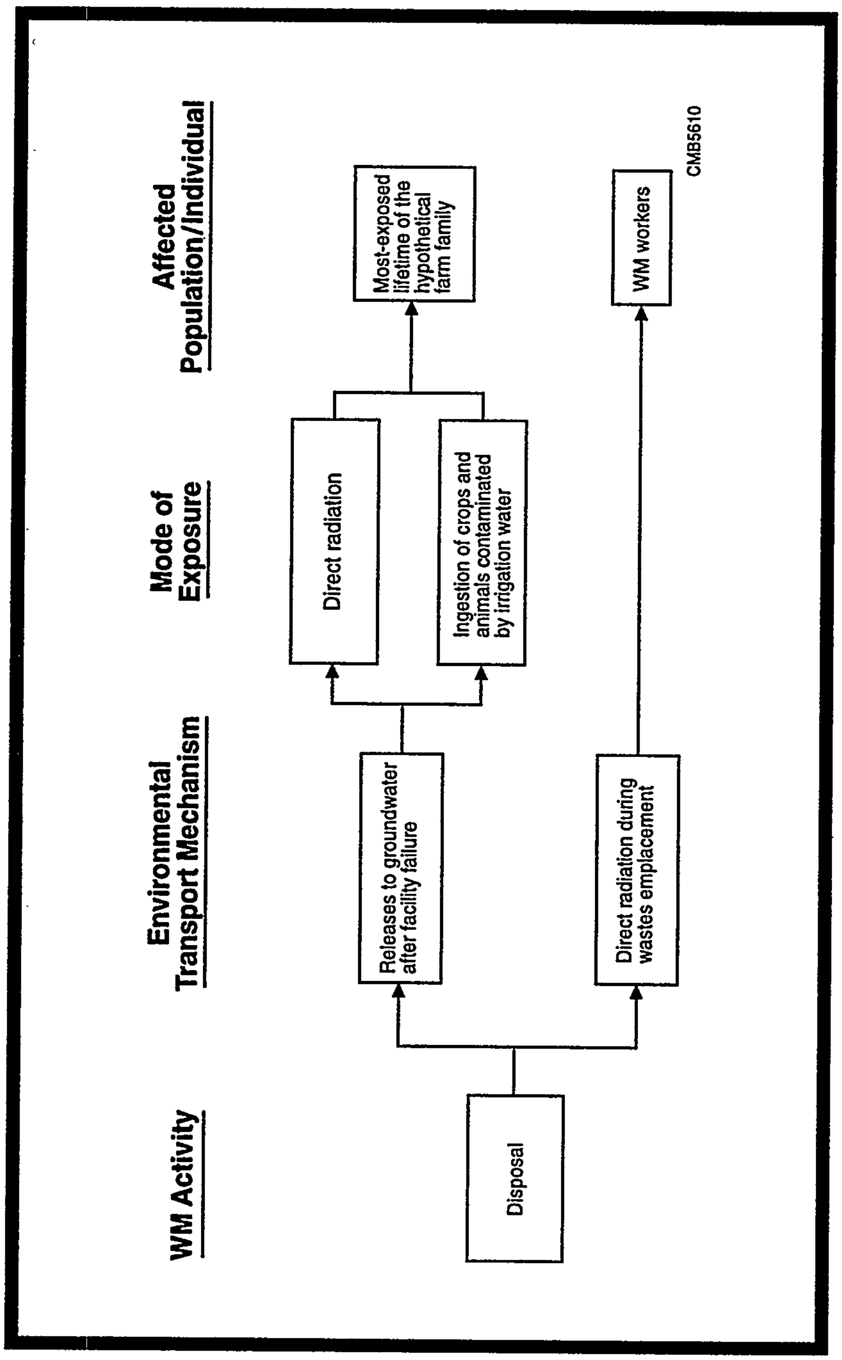

Figure 5.4–6. Exposure Pathways for the Farm Family and Waste Management Workers for Disposal Activities

process wastewaters from these facilities would be discharged to aqueous waste treatment facilities. After treatment, wastewaters would be recycled or discharged from these plants. All wastewaters, including storm waters, would be discharged in compliance with site-specific DOE, National Pollutant Discharge Elimination System (NPDES), or industrial wastewater discharge limits, which are established based upon consideration of the potential health and environmental effects of contamination of the receiving body. Disposal facilities may eventually degrade and release contaminants to the groundwater. Resultant contamination of surface water from the groundwater is dependent on the specific location of the disposal facility with respect to the surface water; however, dilution of the contaminants in "clean" surface waters is likely to result in surface water concentrations that are much lower than the concentrations in the groundwater.

Since the WM PEIS does not attempt to make waste management facility technology or siting decisions, there would be a high degree of uncertainty associated with any quantitative surface water pathway exposure estimates. Consequently, the WM PEIS did not conduct a detailed evaluation of this pathway. Surface water pathway analyses are appropriate for sitewide or project-level NEPA reviews where potential impacts may appear important to decision making.

Radioactive decay and the ingrowth of daughter products are taken into account in the estimation of radiological dose from direct radiation, ingestion of contaminated groundwater, and inhalation of contaminated air. Since treatment and storage periods are assumed to be 10 years in duration, radioactive decay and ingrowth are estimated for external radiation for an average of five years in order to capture the doses of photon-emitting daughters. For the groundwater pathway, radioactive decay is considered at several points in the exposure assessment. The first point is prior to the breach of the disposal facility, where decay is evaluated and the contaminant inventory is modified accordingly. Decay then occurs after the breach of the disposal facility and during transport to the vadose zone is accounted for prior to the transfer of flux rates to the MEPAS model. The MEPAS model then accounts for radioactive decay and ingrowth involved in transport through the vadose and saturated zones. All doses from daughter products are attributed to the parent radionuclide. The GENII model used in estimating exposure from inhalation of airborne radionuclides also accounts for radioactive decay and ingrowth, and assumes, as in the groundwater pathway, that all doses from daughter products are attributed to the parent radionuclides.

Offsite population and noninvolved onsite workers were assumed to be exposed to radionuclides through inhalation of airborne vapor and dust. This aspect of exposure lasts throughout waste treatment, storage, and disposal operations. Onsite and waste management workers, during nonworking hours, are counted among the individuals living near the site (offsite population).

Onsite workers were assumed to experience chemical and radiological exposure from treatment, storage, and disposal facilities. The exposure pathways for these workers were assumed to be inhalation of vapor and dust, and direct external radiation. These workers are also subject to a variety of construction- or operation-related accidents. Workers were assumed to be wearing the proper industrial safety and health equipment for the task being performed (construction in a nonradioactive environment, operations in a radioactive environment).

The population living and traveling along the transportation routes are assumed to be exposed to radionuclides by way of direct radiation under routine conditions and both direct radiation and inhalation of airborne vapor and dust under accident conditions (SNL, 1993). Onsite industrial and transportation accidents were evaluated using the RISKIND model (ANL, 1993). Exposure to hazardous chemicals under accident conditions is assumed to occur only by inhalation of vapors and dust. Direct exposure by other pathways such as dermal (skin) absorption, is possible, but these routes are expected to result in much lower exposure than the inhalation pathway doses. The public is assumed to be exposed to vehicle exhaust fumes. The exposure pathways for transportation workers are assumed to be the same as those for the general population.

5.4.1.4 Health Impacts

Health impacts, which may range from bodily injury or illness to death, can result from exposure to radionuclides; exposure to chemicals or exhaust fumes; or physical trauma (crushing, burning, electrocuting). The effects on people of radiation that is emitted during disintegration (decay) of a radioactive substance depends on the kind of radiation (alpha and beta particles and gamma and x-rays) and the total amount of radiation energy absorbed by the body. The total energy absorbed per unit quantity of tissue is referred to as the absorbed dose. The absorbed dose, when multiplied by certain quality factors and factors that take into account different sensitivities of various tissues, is referred to as the effective dose equivalent, or where the context is clear, simply dose. The common unit of effective dose equivalent is the rem or millirem (1 rem equals 1,000 millirem).

An individual may be exposed to ionizing radiation externally, from a radioactive source outside the body, and/or internally, from ingesting or inhaling radioactive material. The external dose is different from the internal dose. An external dose is delivered only during the actual time of exposure to the external radiation source. An internal dose, however, continues to be delivered as long as the radioactive material remains in the body, although both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time. Health impacts from radiation exposure, whether from sources external or internal to the body, generally are identified as "somatic" (affecting the individual exposed) or "genetic" (affecting descendants of the exposed individual).

Adverse health impacts associated with chemical exposure include cancer and a range of noncancer toxicity effects, including organ system toxicity (e.g., liver, respiratory, cardiovascular), neurotoxicity, immunotoxicity and developmental and reproductive toxicity. The risk of cancer incidence from exposure to hazardous chemicals is not directly comparable to the risk of cancer incidence from exposure to radionuclides. Section D.2.6.3 of Volume III provides additional information about comparing the potential health impacts of radionuclide versus hazardous chemical exposures.

The details of the methodologies used to estimate cancer fatalities, cancer incidence, adverse genetic effects, and noncancer toxic effects are discussed in Appendix D, Section D.2. An overview of uncertainties in health impacts is given in Appendix D, Section D.2.15.

Cancers and some birth defects are believed to result from certain genetic changes in specific individuals in a given generation; however, not all genetic effects result in disease. Genetic effects include gene mutations (alterations in the elementary units of heredity—the genes) and gross chromosomal aberrations (alterations in the structure or number of chromosomes). For the purposes of this PEIS, risks for genetic effects were calculated only for radionuclides; genetic toxicity from chemicals is more difficult to assess because of its diverse nature.

Cancer Fatalities. Cancer fatalities are the excess deaths (deaths that would not otherwise have occurred) resulting from all types of cancer over the lifetime of an individual measured as a frequency (or incidence) in a population, or a probability for individuals. Cancer fatalities resulting from airborne exposures to radionuclides are calculated over an assumed 70-year lifetime. Cancer fatalities resulting from groundwater exposures to radionuclides are calculated over a period of up to 10,000 years after the disposal facility has been breached.

Because of the nature of the biological processes by which chemicals or radiation are currently understood to induce cancer, the conservative approach used in this PEIS assumed that there is no threshold below which there is no risk for cancer, and that the risk of cancer from multiple exposures to different sources is additive. As described in Section D.2.8.2 of Volume III, cancer risks from radiological exposure were estimated using the radiological risk factors developed by the International Commission on Radiological Protection (ICRP). A certain percentage of radiologically-induced cancers were assumed to be fatal (ICRP, 1990). Similar assumptions regarding fatalities from chemically induced cancers are not possible because of the diverse nature of chemically induced cancer.

Cancer fatalities are used in the WM PEIS as a representative health risk endpoint because the occurrence of the other health impacts evaluated (except noncancer toxicity) generally follows the same pattern as radionuclide-induced cancer fatalities. Cancer fatalities in the offsite population were calculated for radionuclides released during routine operations of treatment or storage facilities, during facility accidents, and in the public along transportation routes.

Cancer Incidence. Not all cancers are fatal. The total cancer incidence encompasses all cancers, not just cancers that result in death. The concepts discussed above with regard to cancer fatalities also apply to the consideration of total cancer incidence. For the purposes of this PEIS, radiation cancer incidence and chemical cancer incidence are separately evaluated and reported.

With respect to radiation-induced cancers, the number of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases. Note that both the total cancer incidence and the nonfatal cancer incidence values are overestimated by a factor of about two. The ICRP dose conversion factors used in the WM PEIS to convert radiation exposure to estimates of total cancer incidences contain a relatively large component of skin cancers. Such cancers generally result from external exposures to radiation. However, the exposure pathways evaluated in the WM PEIS (e.g., inhalation or ingestion of radionuclides) are largely internal pathways. These internal exposures to radionuclides are not likely to induce large numbers of skin cancers.

Noncancer Toxic Effects. Although carcinogens (cancer-causing agents) are emphasized because they are believed to have no threshold, most mechanisms of noncancer toxic effects do have thresholds below which no toxic effects are observed. For noncarcinogens, a procedure for comparing hazards has been developed by comparing the exposure concentration or dose to the concentration or dose believed to have no appreciable adverse effects. For members of the offsite population (including sensitive subgroups of the offsite population) assumed to be continually exposed to a chemical throughout their lifetime, or portions of their lifetime, this comparison standard is the reference dose or reference concentration. The quantitative ratio of the exposure concentration (or dose) to the reference concentration (or reference dose) is called the "Hazard Quotient." The sum of all chemical-specific Hazard Quotients is the Hazard Index, which is used by EPA (and in the WM PEIS) to measure the risk of noncancer health effects.

Offsite Population. Health impacts to the offsite population resulting from releases of chemical and radiological contaminants from treatment and storage facilities were evaluated as potential latent cancer fatalities, cancer incidences, genetic effects, and noncancer toxic effects (for chemical contaminants). Offsite population sizes were based upon 1990 U.S. Census data (DOC, 1992a).

Health Impacts to Workers. In addition to potential impacts from airborne exposures estimated for the offsite population, onsite workers will be at risk for health effects resulting from construction and operation injuries. This category includes all significant physical injuries sustained by workers in various job classifications. Injuries are considered together regardless of their nature and are measured as a statistical frequency per labor hour. Some percentage of construction and operation injuries were assumed to result in death. The percentages of construction and operational injuries resulting in death were obtained from the Bureau of Labor Statistics records concerning the Sanitary Services occupational group, which includes plant operations (BLS, 1992, 1993).

For noncarcinogenic risks for waste management workers, estimated exposures were compared to the established chemical-specific occupational exposure limit values. This ratio is referred to in the WM PEIS as the "Exposure Quotient" and it is analogous to the "Hazard Quotient" used to estimate noncancer effects in the offsite population. Unlike carcinogenic risk, the hazard/exposure quotient is not directly related to frequency of disease, but provides a standard way to compare different exposures to noncarcinogens. The sum of all Exposure Quotients is the Exposure Index. Exposure Quotients and Exposure Indices were calculated only for chemical contaminants.

Note that WM worker population radiation exposures are presented as "person-rem" estimates in Volume I and as "FTE-rem" estimates in Appendix D of Volume III. In Appendix D, to make it possible to compare estimated worker exposures to regulatory criteria, staffing was expressed as the number of "full-time equivalents" (FTEs). An FTE was assumed to be commensurate to one individual working full-time in a waste management facility. In reality, one FTE could represent several individuals who are not exposed full-time to waste management activities, but whose *cumulative* work time totals one FTE. Because the risk of exposure could be shared by more than one worker working less than full-time in a waste management facility, risks to actual individual workers might be overestimated. Therefore, when interpreting the Volume I risk analysis results for WM workers readers may find it useful to interpret person-rem as FTE-rem.

Health Impacts to Workers and Offsite Population From Transportation. The same exposure-related health impacts discussed above for treatment and storage facilities can result from transportation of waste. Transportation risks were estimated for workers and the public for routine operations and accidents. These risks were based on State data on the frequency of accidents for trucks and trains per mile traveled. The number of shipments by truck or train were calculated for the WM PEIS based on waste load, whereas mileage was dependent on the sites proposed for the waste management facilities. Calculation of truck mileage was done using the HIGHWAY 3.1 model, and calculation of rail mileage was done using the INTERLINE 5.0 model. These models are the standard means of DOE estimation of truck and rail shipping distances.

National average rural, suburban, and urban population densities were used in the WM PEIS transportation risk analysis for all transportation routes, consistent with DOE practice. This approach was considered appropriate because of the programmatic nature of the WM PEIS. In general, these averages tend to be conservative (i.e., overestimate) compared with route-specific values. Therefore, the estimated risks in the WM PEIS are somewhat higher than if route-specific population densities were used. For complexwide programmatic purposes, the WM PEIS used an external dose rate of 1 mrem/hour at 1 meter from the surface of the shipment for all DOE LLW shipments. This dose rate is based on historical shipment data. The shipment external dose rates for LLMW, TRUW, and HLW are identified in Section E.6.2 of Volume IV.

Interpreting Risk Results. The goal of the WM PEIS risk analyses is to provide estimates of health risk to aid in determining the advantages and disadvantages of implementation of the various waste management alternatives. The risk results are best interpreted as *relative* differences among alternatives rather than as absolute point estimates of risk.

For example, consider a decentralization alternative (Decentralized Alternative 1) that affects the populations at 12 sites and a centralization alternative (Centralized Alternative 1) that affects the population at only one site. If the number of cancer fatalities in the offsite populations of all sites in Decentralized Alternative 1 is *numerically* higher than the number of cancer fatalities in the offsite population of the one site in Centralized Alternative 1, Decentralized Alternative 1 is the highest risk case, for the offsite population cancer fatality endpoint, at the *program level*. Note that each health risk endpoint should be considered independently; values for different endpoints should *not* be added to obtain overall estimates for a given group of receptors. That is, radiation exposure cancer fatalities for waste management workers should *not* be added to physical hazard fatalities to obtain an estimate of the total number of fatalities for this receptor group.

The WM PEIS risk analyses also provide estimates of *site-level* risks. For example, suppose the overall programwide risk of latent cancer incidence from radionuclide exposure under Decentralized Alternative 1 is 0.8 (or 8E–01), and this total risk is distributed across 23 million people, the sum of the offsite populations at all 12 sites involved in that alternative. If this programwide risk (8E–01) is divided by the total affected population (23 million), the resulting number, 0.000000035 (or 3.5E–08), might be considered the "average" risk to an individual member of the programwide offsite population. Note that this number is *not* the risk to the MEI and will in all cases be less than the risk to the MEI. This is because on the average, members of the general population receive less exposure, by definition, than the MEI. Although this "average" individual risk is *not* a formal construct in risk analysis, it may be helpful to the reader for comparing the risk estimates among alternatives or sites. Common activities that produce a comparable risk of death per year are found in Table 5.4–4.

For air emissions a comparison benchmark is the National Emission Standards for Hazardous Air Pollutants (NESHAP) for radionuclides (40 CFR 61), which has a goal of individual lifetime risk no greater than 1 in 10,000, which is approximately equivalent to the standard of 10 mrem/year. All measures of risk, including population risk, should be examined to determine if the MEI risk should be allowed to exceed this value or be constrained to a lesser value.

Another relevant benchmark is the disposal standard for spent nuclear fuel, HLW, and TRUW (40 CFR 191), which states that disposal of these materials in compliance with the containment requirements should not result in MEI exposures of greater than 15 millirem/year. Other standards include drinking water standards, with individual risk goals of 1 in 10,000 or lower for carcinogens, worker radiation protection

Table 5.4–4. Risks Estimated to Increase Chance of Death in Any Year by One in a Million

Activity	Cause of Death
Smoking 1.4 cigarettes	Cancer; heart disease
Traveling 16 km (10 mi) by bicycle	Accident
Flying 1,600 km (1,000 mi) by jet	Accident; cancer caused by cosmic radiation
Existence of potassium-40 in a human body	Cancer caused by naturally occurring radiation
Drinking 30 12-oz cans of diet soda	Cancer caused by saccharin

Sources: Slovic (1986) and Eisenbud (1987).

standard (5 rem per year), and the maximum annual allowable radiation dose to the members of the public from DOE-operated nuclear facilities (100 mrem per year) (DOE, 1990).

Finally, exposure to direct radiation and radionuclides should be considered in the context of background radiation. The average individual in the United States is estimated to receive a dose of about 360 mrem (0.3 rem) per year from all sources combined, including medical sources of radiation (such as x-rays — e.g., chest x-ray dose is about 8 mrem, diagnostic hip x-ray dose is about 83 mrem), and natural background radiation (such as radon gas). This dose results in a calculated individual lifetime risk of fatal cancer of about 1 in 100 (40 CFR 61).

With respect to accident scenarios, where individuals such as waste management workers may receive high short-term (or acute) doses, a person must receive a dose approaching the LD50 dose level before there is a high probability of near-term death (NAS, 1983).

5.4.2 Air Quality Impacts

Air quality impacts were assessed for the construction of new treatment, storage, and disposal facilities; for the operation and maintenance (O&M) of the facilities; and for shipment of wastes between sites. The air quality impacts analysis estimated the air emissions effects for criteria air pollutants, hazardous air pollutants

(HAPs, including radionuclides), and toxic air pollutants (TAPs). Descriptions and assessment criteria for these classes of pollutants are presented below. The potential impacts of emissions of ozone-depleting substances (e.g., chlorofluorocarbons (CFCs) and halons) were also evaluated. Air quality impacts were analyzed only for those pollutants where emissions estimates were provided. A summary of the air quality impacts analyzed in the WM PEIS is presented in Table 5.4–5.

Criteria Air Pollutants. In compliance with the Clean Air Act (CAA) (42 USC 7401), EPA has promulgated National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants (40 CFR 50): carbon monoxide (CO), sulfur dioxide (SO_2), particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}), ozone (O_3), nitrogen dioxide (NO_2), and lead (Pb). These pollutants are

Table 5.4–5. Air Quality Impacts Analysis: Summary of Emissions Evaluated

Pollutant Class	Relevant Waste Types	DOE Site-Level Analysis			National Analysis	
			O&M Emissions			
		Construction Emissions	Local Stationary Source Emissions	Local Transportation Source Emissions	Transportation Corridor Emissions	Total National Emissions
Criteria Air Pollutants	All Five Waste Types	Local Construction Equipment Emissions and Worker Vehicle Emissions (Tons/Yr)	Local Stationary Source Emissions from Proposed Waste Management Facilities (Ambient Concentrations and Tons/Year)	Offsite Emissions from Worker Vehicles and Waste Transport Within 50 Miles (Tons/Year)	Total Emissions From Waste Transport outside 50-Mile Radius of Sites (Tons/Year)	Sum of Onsite, Offsite, and Transportation Corridor Emissions (Tons/Year)
Radio-nuclides	TRUW, LLW, & LLMW[a]	No Emissions During Construction	Local Stationary Source Emissions From Proposed Waste Management Facilities (Total Airborne Radionuclides Based on Radiation Dose From All Exposure Pathways)	Not Calculated for Worker Vehicles. Assumed to Be Negligible From Routine Waste Transport	Assumed to Be Negligible From Routine Waste Transport	Assumed to Be Negligible
Other Hazardous and Toxic Air Pollutants	TRUW, HW, & LLMW[a]	Assumed to Be Negligible	Local Stationary Source Emissions From Proposed Waste Management Facilities (Pollutant-Specific Ambient Concentrations)	Not Calculated for Worker Vehicles. Assumed to Be Negligible From Routine Waste Transport	Assumed to Be Negligible From Routine Waste Transport	Assumed to Be Negligible

[a] Emissions of radionuclides and other hazardous constituents from the storage of vitrified HLW are assumed to be negligible due to the physical form of the HLW. Once HLW is vitrified, the glass matrix binds the radionuclides and hazardous chemicals, such that releases to the atmosphere are negligible.

regulated both in terms of annual production in tons per year and in terms of ambient concentrations emanating from point and mobile sources. Unlike the other five criteria air pollutants, ozone is not a direct emission but is formed in the atmosphere through a complex reaction of ozone precursor pollutants, sunlight, and temperature. Ozone precursor pollutants include nitrogen oxides (NO_x) and nonmethane hydrocarbons (NMHCs), which include the class of compounds known as volatile organic compounds (VOCs). The analysis of ozone impacts was performed by evaluating NO_x and VOCs emissions.

Hazardous Air Pollutants. Section 112 of the CAA requires EPA to establish technology-based standards for sources of 189 pollutants listed in the statute, and to specify categories of sources subject to the emission standards. The NESHAP are promulgated in 40 CFR 61. HAPs include cancer-causing agents, such as arsenic, benzene, carbon tetrachloride, formaldehyde, and radionuclides, as well as materials with noncancer health hazards, such as fluoride, ammonia, and hydrochloric and sulfuric acids. EPA regulates radionuclides as a total annual dose limit under the NESHAP. Radionuclides are also regulated by the Department of Energy (DOE Order 5400.5 [DOE, 1990] and proposed 10 CFR 834 [DOE, 1993b]) as a total dose limit.

Toxic Air Pollutants. Toxic air pollutants include cancer-causing agents and compounds with noncancer health hazards. These substances are regulated by the EPA and on a state or local basis, through allowable ambient standards or guidelines.

Ozone-Depleting Substances. Ozone-depleting substances are regulated through the CAA and by the Montreal Protocol on Substances that Deplete the Ozone Layer. The CAA includes requirements for controlling ozone depleting substances that are generally consistent with, but in some cases more stringent than those in the Montreal Protocol. Title VI of the CAA calls for a phaseout of CFCs by January 1, 2000. In addition to the phaseout of ozone-depleting substances (ODSs), Title VI includes a variety of other provisions intended to reduce emissions of ODSs and promote the recycling of these substances.

Air Quality Impacts Analysis. The air quality impacts analysis estimated annual criteria pollutant emissions in tons per year (tpy) for construction and O&M activities. HAPs/TAPs concentration impacts were not estimated for construction activities but were estimated for the treatment of waste by thermal destruction during O&M.

Annual criteria air pollutant emissions in tons per year from construction activities were estimated based on emission rate data for construction equipment and worker vehicles traveling to and from the work site on a daily basis. Annual criteria pollutant emissions in tons per year from waste management activities were estimated based on standard EPA emission rate factors for O&M facilities (see EPA, 1995), thermal destruction of waste, worker vehicles, and transportation of waste.

Criteria air pollutant ambient concentration impacts were estimated based on thermal destruction emission rate factors and concentration impact estimates obtained from computer dispersion modeling. The HAPs and TAPs concentration analysis assumed that the most conservative estimate of impact would be from concentrations that the offsite MEI would be subject to in the human health risk assessment. Therefore, the HAPs and TAPs air quality impacts analysis for thermal destruction emissions used data on emissions, airborne concentrations, and MEI doses assembled for the human health risk assessment. The estimated concentrations of criteria air pollutants were compared to the NAAQS, while HAPs and TAPs concentrations were compared to applicable EPA or State ambient concentration guidelines.

The air quality analysis assumed that transportation sources may be an important source of criteria pollutant emissions in addition to those from the facilities. Transportation sources were not assumed to contribute significantly to hazardous or radioactive airborne contaminants in routine operations. Therefore, for criteria air pollutants only, in addition to estimating ambient concentrations from facility sources, the analysis estimated local transportation source annual tonnage of criteria air pollutants, intersite transport annual tonnage of criteria air pollutants, and a national annual tonnage of criteria air pollutants from all activities proposed for each waste type under each alternative.

The focus of the air quality analysis for proposed onsite waste management activities was on estimating potential emissions of criteria air pollutants, HAPs (including radionuclides), and TAPs from operating treatment facilities, where the treatment facility is a stationary source of those emissions. Because ozone is formed photochemically, at a substantial distance downwind from an ozone precursor emission source, the analysis of ozone effects from these operations was done separately and used a different estimation technique.

Airborne concentrations of criteria air pollutants and HAPs from proposed thermal destruction operations were estimated by calculating the highest concentration of each substance likely to be emitted at each site using the "ISC2" computer dispersion model used in the human health risk assessment. The model estimates downwind concentrations of contaminants as they originate from a known source and disperse with the wind. The model requires input of appropriate local weather data and important facility data, including stack heights, diameters, and discharge rates.

Emission rate data for waste management facility fuel use were obtained from the most recent version of EPA's *Compilation of Air Pollutant Emission Factors, Volume I: Stationary, Point, and Area Sources* (EPA, 1985). Fuel use emission estimates were based on emissions for an industrial boiler using either gaseous or liquid fuels. Criteria air pollutant emission rate data for thermal destruction were obtained from a review of EPA literature.

Rather than estimating individual radionuclide concentrations downwind from proposed treatment facilities, a screening analysis was used to determine whether radionuclides as a group would exceed the overall NESHAP dose standard of 10 millirem (mrem) per year. Annual doses to the offsite MEI were obtained from the GENII model for each site and waste management alternative. The dose values were compared to the NESHAP annual dose standard and discussed if they exceeded 10% of the standard. Comparison to the standard is not intended to demonstrate compliance for permitting purposes.

The potential impacts of transportation on air quality were estimated. Specifically, the analysis examined:

- Exhaust emissions from on-road vehicle and railroad diesel engines during transport of wastes between sites
- Increased vehicle traffic at each site based on the total shipments reaching a site and on the privately owned vehicles used by workers going to and from the waste management facilities

Local impacts for truck or rail shipments were based on emissions estimates for that segment of each waste shipment within a 50-mile radius of the site. Shipment emission estimates outside the 50-mile radius were added to national transportation source emission estimates for each waste management alternative. Worker vehicle trips were based on a daily round-trip distance of 40 miles for a work period of 240 days per year. A quantitative analysis of the contribution of vehicle exhaust was performed for the exhaust compounds CO, NO_2 (as NO_x), PM_{10}, and VOC (EPA no longer considers airborne lead to be a problem because unleaded fuels are now the norm). NO_x and VOC are ozone precursor pollutants and are of particular concern in ozone nonattainment areas. Emission factors for the quantitative analyses were estimated using the most recent version of the EPA-approved vehicle emissions model, Mobile5a.

Criteria air pollutant effects were assessed for each of the six criteria air pollutants based on the air quality attainment status of each site's air quality control region. In general, a sites applicable air quality control region is in attainment for a particular criteria air pollutant if monitored ambient concentration levels are below the NAAQS for that pollutant. The site's applicable air quality control region is in a nonattainment area for a particular criteria air pollutant if ambient concentration levels are equal to or exceed the NAAQS for that pollutant.

Any predicted increases to ambient concentration levels in areas designated as "in attainment" by EPA were compared to the NAAQS. If the increased estimated ambient concentrations equaled or exceeded the NAAQS, then that alternative and the affected area were identified in the WM PEIS. The annual criteria emissions, in tons per year, were compared to the allowable increase levels specified in 40 CFR 52.21, "Regulations for the Prevention of Significant Deterioration (PSD) of Ambient Air Quality." PSD regulations are applicable to attainment areas for each of the criteria air pollutants. These allowable increases are referred to as PSD increments and PSD significant emission levels (SELs). PSD increases account for all stationary source emissions that can be reasonably attributed to the action but do not account for emissions from mobile sources. If the estimated annual emissions for an alternative are equal to or exceed the allowable PSD SELs increments, then that alternative and the affected area were identified in the WM PEIS text. Sites that exceed the allowable PSD increments may require additional control measures to reduce criteria pollutant emissions to acceptable levels.

New major stationary sources or major modifications of existing sources located in attainment and nonattainment areas for any criteria air pollutant must conform to New Source Performance Standards (40 CFR 60). In addition, Federal actions that are located in nonattainment areas are required to follow the guidelines of EPA's General Conformity Rule (GCR) (40 CFR 93) (EPA, 1993). The conformity rule establishes specified minimal levels for criteria air pollutant emissions, in tons per year, based on the air quality control region's nonattainment designation. Actions producing emissions that are below the minimal levels are considered to conform, while those at or above the limits are required to perform a conformity determination as outlined in the conformity rule. The conformity rule accounts for all stationary and mobile sources of emissions that can reasonably be attributed to the action.

Ozone pollution can be caused by reactions between VOC and NO_X in the presence of sunlight, and it generally reaches its maximum concentration many miles downwind of the sources of these substances. The impacts of the alternatives on ambient ozone levels were assessed by assuming that if emissions and concentrations of VOC and NO_x associated with each alternative are within applicable PSD, GCR, or NAAQS, ozone production would be minimal.

Impacts to the stratospheric ozone layer due to emissions from waste management activities were estimated. The analysis was performed at all treatment sites in an alternative since emissions of ozone depleting substances is a global rather than a site issue. The analysis was performed for waste types where treatment of waste containing hazardous constituents occurs (e.g., LLMW, TRUW and HW). The compounds analyzed include the ozone depleting substances identified by EPA in 40 CFR 82. Emissions of ozone depleting substances from thermal treatment were tallied from information supplied by the health risk assessment. The total emissions from each alternative were found to be exceedingly small for all waste types, and in fact were less than 0.1 pound per year for all LLMW alternatives (DOE, 1996a). These minor emissions would not be expected to have any measurable affect on upper atmosphere ozone levels. Emissions of ozone depleting substances from other treatment, storage and disposal operations were assumed to be small due to the nature of these activities, and the mandated phase-out of the use of ozone depleting substances.

Construction activities could affect air quality by causing fugitive dust emissions and contributing vehicle, heavy equipment, and mobile power generator exhaust emissions. Estimates of fugitive dust and exhaust emissions were made for each site under each alternative. The estimates were based on the extent of land clearing required to build the proposed facility, the size of the construction workforce, and the requirements for trucks, heavy equipment, and mobile generators.

5.4.3 WATER RESOURCES IMPACTS

The analysis evaluated water resource effects based on engineering estimates of expected water use and liquid discharges from the waste management activities under each waste type. The analysis quantified water quality effects for those waste types for which disposal is proposed at DOE sites under the assumption that the disposal facilities would deteriorate after closure and that such disposed wastes might contaminate groundwater. Other potential water resources impacts are discussed qualitatively.

At certain DOE sites, impacts from normal operations to surface water or groundwater or both can be ruled out, given the source of water or the receiving body for effluents, as follows:

- Municipal water is used as the source of water for RFETS, SNL-NM, and WIPP; therefore onsite surface and groundwater resources would not be affected by water withdrawals.
- Groundwater is used as the source of water for the water supply at ANL-E, BNL, FEMP, INEL, LANL, LLNL-Site 300, NTS, the Pantex Plant, PORTS, and SRS; therefore, impacts to surface water resources are likely to be small as a result of groundwater withdrawals.
- Surface water is used as the source of water at the Hanford Site, ORR, Paducah, and WVDP; therefore, impacts to groundwater resources are likely to be small as a result of surface water withdrawals at these sites.
- Wastewater is discharged to municipal wastewater treatment systems at SNL-NM; therefore, onsite surface water resources would not be affected by effluent discharges.
- Wastewater is not discharged to natural flowing surface water bodies at the Hanford Site, INEL, LANL, LLNL-Site 300, NTS, the Pantex Plant and WIPP; therefore, impacts to surface water resources are likely to be small as a result of effluent discharges at these sites.

5.4.3.1 Water Availability

Impacts on water availability were analyzed by comparing the rates of water use and wastewater discharge estimated for each site during construction and operation of proposed waste management facilities to volumes or use rates for current water sources. For sites that obtain water from surface water sources, a comparison was performed for both current use and stream flow.

For each waste type, water use rates for construction and operation activities at each site under each alternative were taken from technical reports prepared for specified alternatives or interpolated from the technical reports for the remaining alternatives. Total water use at a site was computed as the sum of water use for waste treatment, storage, or disposal operations.

The analysis assumed that water for the proposed waste management activities would be withdrawn from the current water source at each site. The surface, groundwater, or municipal water source at each site is part of the water resources affected environment data in Chapter 4. Where surface water is the current source, surface flow rate data were also assembled.

5.4.3.2 Water Quality Impacts From Disposal of LLMW and LLW

Groundwater quality may be affected in the future assuming there is a loss of institutional control at disposal sites and subsequent deterioration of disposal facility integrity. Disposed waste contaminants could then leach into groundwater and subsequently appear downgradient in well water. Analysis of this possible effect used the modeling for the human health risk assessment. The transport and fate of disposed radionuclides, and hazardous constituents were estimated using the Disposal Unit Source Term (DUST) and Multimedia Environment Pollutant Assessment System (MEPAS) models that tracked the contaminants as they moved from the disposal location to the point of exposure for a hypothetical farm family living 300 meters downgradient of the disposal facility.

Input data for the water quality analyses were assembled for LLMW and LLW, the only two waste types that will be disposed of at DOE sites under this PEIS. These data were taken from two sources:

- DUST/MEPAS modeling that estimated human health risks from use of contaminated groundwater for drinking and for crop irrigation
- Estimated quantities of radionuclides and hazardous chemicals in the waste

The water quality impacts analysis applied the radionuclide and hazardous constituent inventory data to the health risk modeling results in order to calculate contaminant concentrations in a hypothetical well located 300 meters downgradient from each disposal unit. The analysis accounted for the degradation of the wastes during the time period between disposing of the wastes and loss of containment (ranging from 0 to 700 years depending on the technology), and for creation of radioactive daughter products from the decay of disposed radionuclides (ORNL, 1995b). Disposal of 36 radionuclides was evaluated for LLMW and LLW; disposal of 15 hazardous constituents was evaluated for LLMW. The constituents analyzed in the WM PEIS are listed in Section C.4.3.5 of Volume III.

Estimated radionuclide and hazardous constituent concentrations in the hypothetical downgradient well were compared to drinking water standards promulgated by EPA in the Primary Drinking Water Regulations (40 CFR 141) and in DOE Order 5400.5 (DOE, 1990). These drinking water standards are listed in Section C.4.3.5 of Volume III. Drinking water standards promulgated under the Safe Drinking Water Act are applicable to treated drinking water at the tap, and therefore are not directly applicable to groundwater quality. Since there are no Federal standards for groundwater quality protection, predicted concentrations of contaminants in the groundwater are compared with drinking water standards to provide an indication of the level at which adverse impacts to water quality may occur. These criteria are commonly used as

Applicable or Relevant and Appropriate Requirements (ARARs) to determine appropriate levels for groundwater cleanup under RCRA and CERCLA cleanup actions. Since drinking water standards adequately protect human health, groundwater contamination at or below these levels is considered to result in low risk to human health. Federal water quality standards, rather than state standards, were used to provide a consistent means of comparing among sites.

DOE will evaluate the performance of disposal facilities at each site in detail in the DOE's Performance Assessment process. If significant groundwater contamination were predicted by the Performance Assessment process, changes in the waste acceptance criteria would be made to limit disposal of the waste causing the significant groundwater contamination. The waste would require further treatment prior to disposal, would be disposed of at another DOE site where the waste meets the waste acceptance criteria, or would be stored until a method was found to treat or dispose of the waste. In no case would DOE knowingly dispose of waste in violation of legal requirements.

5.4.3.3 Other Water Resources Impacts

Some impacts on water resources were assumed to be minimal at all sites or at particular sites regardless of which waste type and alternative are being considered. In order to focus the analysis on significant environmental impacts that could influence the choice of alternatives, these potential minimal effects are discussed here and therefore not addressed in the waste type impacts analyses in Chapters 6–10. Further evaluations of these potential effects could be conducted as part of sitewide or project-specific NEPA reviews.

The impacts of waste management activities on floodplains cannot be estimated at this time because the specific locations of the waste management facilities at the DOE sites are not analyzed in the WM PEIS. If possible, no new waste management facilities would be located in floodplain areas. As a minimum, facilities managing LLMW or HW would be required to meet additional design criteria and/or siting requirements to obtain a RCRA permit. Compliance with floodplain and wetland review requirements, including Executive Order 11988 (Floodplain Management) and 10 CFR 1022 (Compliance with Floodplain/Wetland Environmental Review Requirements), would be examined in detail when specific locations are proposed in sitewide or project-specific NEPA reviews.

During the construction period, impacts to surface water resources could occur from runoff and sedimentation as a result of site clearing. During operations, impacts to water resources could occur through increased runoff from buildings, parking lots, and cleared areas. The impacts would generally be proportional to the amount of land disturbed during construction and occupied during operations. In all cases the impacts would be minimized by implementation of best management practices for stormwater runoff and erosion control. These practices include the use of silt fences, run-on and runoff diversion ditches, and stormwater retention and sedimentation ponds. Therefore, impacts from these activities are not expected to be major, and should not influence the choice of alternatives. If necessary, these impacts would be considered in sitewide or project-specific NEPA reviews.

During waste management operations, stormwater runoff may be contaminated with materials deposited from airborne emissions. Most of the potentially contaminated stormwater runoff would be contained within onsite stormwater collection ponds. The stormwater runoff would evaporate or infiltrate into the ground, although the ponds may discharge to surface water bodies during high flow conditions. Stormwater runoff would be routinely monitored and any discharges would be in compliance with site-specific permit limits. Stormwater runoff that is not contained within the stormwater management system may contaminate surface waters. This runoff may contain small amounts of contaminants. Controls would be implemented at each site to minimize the potential for contaminated stormwater runoff. Impacts from stormwater runoff are expected to be minor, but are highly site-specific and would depend on the design of the stormwater management system, meteorologic conditions, topography, soil type, and the affected surface water body at the site. These impacts should not influence the choice of alternatives but would be considered in sitewide or project-specific NEPA reviews, if necessary.

During normal waste management operations, no untreated sanitary or process wastewater would be discharged to surface or groundwater. Wastewater would be treated and recycled to the extent possible and then discharged to existing sanitary or process treatment plants, as appropriate. After additional treatment, wastewaters would be discharged from these plants in compliance with all NPDES and industrial wastewater discharge permits. Onsite surface water resources would not be affected by effluent discharges at SNL-NM, because wastewaters are discharged to municipal wastewater treatment systems. Surface water resources have a low potential to be affected by effluent discharges at the Hanford Site, INEL, LANL, LLNL–Site 300, NTS, the Pantex Plant, or WIPP, because generally, wastewaters are discharged to dry stream beds or man-made ponds, and not natural flowing surface water bodies. Even at sites such as ORR and SRS where surface waters could be affected by effluent discharge, it is not always possible to determine which water course(s) would be affected, since the locations of the waste management facilities have not been selected. If necessary, these impacts would be considered in sitewide or project-specific NEPA reviews.

The majority of new aqueous waste would be sanitary waste generated by the employees needed to operate the facilities associated with each alternative. Sanitary wastes by definition are nonhazardous and would be discharged to existing sanitary wastewater treatment facilities. After treatment, sanitary wastewaters would be recycled or discharged from these plants in compliance with site-specific NPDES or industrial wastewater discharge permit limits. The impacts on existing sanitary wastewater treatment facilities are discussed in the infrastructure section of this chapter (Section 5.4.9).

Although the volume of sanitary wastewater may vary between alternatives, it would remain similar in quality. Therefore, current conditions would not change appreciably unless the discharge volume was a large percentage of the flow in the receiving water body. The impacts of combined sanitary and process wastewater discharges on surface water volume were evaluated in the WM PEIS and show only minor (less than 1%) changes in flow. Since the quality of effluent discharges from sanitary wastewater treatment facilities would not change, and the flow would not be a significant fraction of the average flow in the major receiving water body, current monitoring captures most of the water quality effects of sanitary wastewater treatment plant discharges for the alternatives. Therefore, impacts from these activities are not expected to be major and should not influence the choice of alternatives. If necessary, these impacts would be considered in sitewide or project-specific NEPA reviews.

Process wastewater is wastewater potentially contaminated by hazardous or radioactive constituents during treatment, storage or disposal activities. In the WM PEIS, it was assumed that easy-to-treat and hard-to-ship wastes, such as aqueous wastes and slurries (process wastewater), would be treated at the generating site and would not be shipped offsite for treatment. After treatment, wastewaters would be recycled or discharged in compliance with site-specific DOE, NPDES, or industrial wastewater discharge limits. Because process wastewater treatment would continue at the sites where it presently occurs, and the volumes of process wastewater treated at each site would vary only slightly between alternatives, the effects of process wastewater treatment on surface and groundwater quality are largely accounted for in the existing conditions information reported in the affected environment section. Therefore, the impacts from these activities should be similar for all alternatives and should not influence the choice of alternatives. If necessary, these impacts would be evaluated in sitewide or project-level NEPA documents.

Wastewater released by sanitary wastewater treatment plants may enter small onsite water courses before entering the major surface water body near the site. Additional effluents in these small streams may cause erosion and/or sedimentation in the stream channel. Water quality may also be affected since the facility effluents may form a large fraction of the natural stream flow. The effects of effluent discharge on natural surface water bodies would be minimized during the site selection and permitting process. Impacts on small onsite water bodies could be considered in sitewide or project-specific NEPA reviews.

During normal operations of waste storage facilities, no water (including surface water and groundwater) would be allowed to come into contact with the waste. Therefore, surface water or groundwater quality would not be affected because there would be no contaminated runoff. During normal operations of waste treatment facilities, there would be no releases to groundwater. Therefore, groundwater quality would not be affected.

Withdrawals of groundwater to supply water for waste management facilities could cause detrimental movement of existing groundwater contamination plumes. This could occur where water levels are lowered by water withdrawals. Since existing wells will be used to the extent possible, and new wells would be located to minimize their impact on contaminant plume migration, impacts of this sort are unlikely. Potential impacts on existing areas of contamination could be considered in sitewide or project-specific NEPA reviews.

Seepage of contaminated groundwater from disposal facilities could contaminate surface water. This would be expected to occur at sites with shallow groundwater, and surface water bodies that are fed by groundwater discharge (springs). Some sites (INEL, NTS, and Pantex) are located above deep groundwater such that surface water would not be expected to become contaminated. Other sites (LANL, LLNL, SNL-NM, and WIPP) have a low potential for surface water contamination due to the intermittent nature of most of the site streams. Where contaminated groundwater discharges to the surface, dilution in “clean” surface waters would cause concentrations of contaminants in surface water to be lower than concentrations in groundwater. Therefore, the groundwater pathway was assumed to be the major pathway for movement of contaminants beyond the disposal facility boundary, and was the pathway that was examined in detail.

Routine transportation would involve the intersite movement of waste by truck or rail, and the travel of workers to and from work. Waste materials would not be released during routine transport of wastes; therefore, impacts from transportation would be limited to the deposition and runoff of vehicle emissions to surface waters, and the infiltration of materials deposited on the surface to groundwater. The vehicle emissions at any one place from transportation of waste are assumed to be minimal. Therefore, potential impacts to surface water and groundwater from routine transportation would be minimal.

Because the waste would be shipped in NRC or DOT approved containers, impacts to water resources would be unlikely unless a ruptured container fell directly into a surface water body. In the unlikely event that waste was released from a shipping container, cleanup response to the accident would be swift, and the release would be contained and cleaned up as quickly as possible. The spill response and cleanup, and any subsequent remediation, would be conducted in accordance with CERCLA (42 USC 9601 *et seq.*), the National Oil and Hazardous Substances Pollution Contingency Plan, and DOE emergency response requirements. Because cleanup would be swift, no long-term impacts to water quality would be expected. For waste transported in Type B NRC certified containers, the probability of container leakage would be very low during an accident. In addition, it is unlikely that there would be any significant release of radionuclides or hazardous constituents from vitrified waste during an accident. Therefore, it is unlikely that transportation accidents involving Type B containers or vitrified wastes would result in impacts to surface water or groundwater resources.

The primary water-related impacts from WM activities are likely to be through groundwater. Nevertheless, there may be sites at which WM activities could cause surface water impacts. The vulnerability of a site to surface water impacts was estimated by comparing selected environmental data at the site. These data include: (1) precipitation, (2) the characteristics of major surface water bodies near the site such as distance to the site and flow rate, (3) the presence of groundwater discharge to surface water bodies near the site, and (4) the presence of nearby surface water supply intakes downstream from the site.

Several of the sites are located in arid climates with limited rainfall and have no discharges to major surface water bodies (i.e., INEL, NTS, Pantex, and WIPP). Site wastewater discharges and stormwater runoff are unlikely to reach major surface water bodies, and little or no groundwater discharges into streambeds. These characteristics make it unlikely that WM activities would produce major surface water impacts near these sites.

At three other arid sites (LANL, LLNL, and SNL-NM), discharges offsite occur only rarely and are made up of stormwater runoff or snowmelt. At these sites, groundwater can seep into the streambeds of the intermittent streams at times during the year. These characteristics also make it unlikely that major surface water impacts would occur near these sites.

At RFETS, annual average precipitation is also low, but groundwater discharges into the nearby creeks. Parts of the site originally drained via small creeks to two reservoirs that are used for drinking water supplies by the Towns of Broomfield and Westminster. Since 1989, all discharges from RFETS are contained in onsite manmade ponds and diverted to the Broomfield Diversion Ditch, which bypasses the reservoirs and discharges to Walnut Creek downstream from the reservoirs. Although past activities at RFETS have impacted surface water resources, it is unlikely that major impacts to surface waters would occur from the incremental addition of WM activities.

ANL-E, FEMP, Hanford, ORR, PGDP, PORTS, and SRS are located near major water bodies that have large to very large average flows. Groundwater at these sites recharges into the nearby streams and rivers. These characteristics indicate that although some impacts to surface water are likely to occur near these sites, it is unlikely that major surface water impacts would occur.

BNL and WVDP are located near water bodies with small to medium average flows. During wet periods, groundwater discharges to onsite streams. Although these sites are more vulnerable to surface water contamination than the sites discussed in the previous paragraphs, in the near term, surface water impacts from the incremental addition of WM activities are not expected to be major. As described in the Draft WVDP closure EIS (DOE, 1996b), significant impacts to surface water could occur in the future if erosion breaches the waste disposal facilities.

Nearby water supply intakes are not present downstream from most of the sites, although there are nearby water supply intakes downstream from Hanford, ORR, and RFETS. At RFETS, site discharges are routed around the water supply reservoirs. At Hanford and ORR, the large surface water bodies provide a great deal of dilution for any contaminants released from the sites. Therefore, major impacts to downstream drinking water supplies from WM activities are unlikely.

Impacts on surface water resources and drinking water supplies would be considered after the WM facility locations on the sites are selected in sitewide or project-specific NEPA reviews.

5.4.4 ECOLOGICAL RESOURCES IMPACTS

Waste treatment, storage, disposal, and transportation activities may affect communities of plants and animals on and near DOE sites and in the transportation corridors. Three types of impacts were quantitatively evaluated: (1) loss or degradation of terrestrial habitats; (2) toxicity resulting from exposure to radioactive and hazardous contaminants released from waste treatment facilities; and (3) toxicity resulting from spills of radioactive contaminants following transportation accidents.

5.4.4.1 Habitat Impacts

The WM PEIS evaluated the potential for waste management actions to eliminate or disturb portions of existing nonsensitive terrestrial habitat as a result of the site clearing and excavation activities required to build waste treatment, storage, and disposal facilities. Because the specific location of any proposed facility at a given site is not addressed in this PEIS, site-specific impacts on nonsensitive terrestrial habitats at individual sites are difficult to predict or evaluate. However, the WM PEIS analysis assumed that the severity of these impacts would generally be related to the amount of land disturbed in building waste management facilities compared to the overall extent of the range of the plant and animal species that constitute these habitats. Site disturbance is expected to be on the order of acres or tens of acres; plant and animal ranges are on the order of hundreds or thousands of square miles. These comparisons are made in each waste-type impacts chapter.

The potential for site clearing and excavation to affect nearby sensitive habitats, including wetlands and designated critical habitats of Federally- and State-listed endangered and threatened species, was evaluated based on the assumption that the potential for such effects would be proportional to waste management acreage requirements compared to the acreage of nonsensitive land on site. The premise was that the smaller the fraction of available nonsensitive lands that waste management construction required, the greater DOE's flexibility in siting the facility to avoid placement that might affect nearby sensitive habitats. The analysis therefore compared total waste facility acreage requirements at each site having sensitive habitats with the amount of available, nonsensitive land area at each site for each waste type under each alternative. The available land area was determined from site development plans and site environmental reports as either land specifically designated for waste management facility development or as the amount of land remaining after subtracting from the site's total acreage the acreages of wetlands, wildlife management areas, topographic features, existing roads and structures, cultural properties, and other areas and features that would make development unfeasible. The analysis in each waste-type chapter presents percentage figures for those sites and alternatives under which land requirements equal or exceed 1% of the available land. These are noted as those situations that pose the greatest likelihood of effects to nearby sensitive habitats. Site-specific analyses, tiered from this PEIS, would be conducted to evaluate the extent and severity of these potential impacts.

5.4.4.2 Toxicity From Exposure to Contaminants

The impacts of airborne releases of radionuclides to terrestrial animals living in the vicinity of waste treatment facilities was estimated using atmospheric emission/deposition modeling using the GENII model. This modeling, which used the same atmospheric emissions estimates as used in the human health risk assessment, provided estimates of doses of radioisotopes deposited downwind on soils close to the source and soils distant from the source over the 10-year period of operations. The model also estimated uptake from the soils and transfer in a terrestrial food chain leading to exposure of a small mammal used as a model terrestrial receptor (ORNL, 1995d).

All nonvolatile hazardous chemicals expected to be released from waste treatment facilities were included in the analysis; volatile chemicals are not expected to be significantly redeposited to surface soils. Radionuclides that contributed up to 80% of the total released activity were included in the analysis. The remaining activity was contributed by smaller emissions of a large number of radionuclides. Not including these minor radionuclides may be compensated for by the conservative assumptions used to characterize the scenario (e.g., accumulation of contaminants in surface soils for 10-year period of operation with no loss due to decay or transport).

Total internal and external doses for the model receptors were compared to a benchmark value of 100 millirads per day established by the International Atomic Energy Agency (IAEA, 1992). (A millirad—one thousandth of a rad—is a unit of measure for small amounts of energy absorbed by a material.) No-observed-effect levels (NOELs) were used as benchmarks for exposures to chemicals. The resulting ratio of chemical doses to NOELs, the Hazard Index (HI), is used to identify alternatives that may be of concern for potential ecotoxicity. When the dose exceeds the benchmark, that is, when the HI is greater than 1 (HI > 1), there is a potential concern for the development of adverse effects in terrestrial receptor populations as a result of the exposure.

5.4.4.3 Effects on Sensitive Species

The ecological impacts analysis in this PEIS does not determine the likelihood and severity of habitat impact effects on sensitive species, including Federally and State-listed endangered and threatened species, because the specific waste management facility locations at the various sites are not yet proposed. These evaluations would be included in sitewide or project-level NEPA analyses. However, the WM PEIS analysis does provide information to the decisionmaker concerning the sensitive species that may be affected by the proposed waste management facilities at each site. Chapter 4 describes the sensitive species at each site and provides a summary table of the Federally- and State-listed species known to occur, or with the potential to occur, at the 17 major sites. The waste-type impacts chapters list in tabular form the numbers of Federally- and State-listed endangered and threatened species that might be affected at each site under each alternative where DOE is proposing to build waste management facilities.

In addition to impacts through disturbance of habitat, sensitive species may be affected by exposure to contaminants released from waste treatment and storage facilities. These impacts are expected to be similar to those estimated for nonsensitive species, as described previously in this section (see discussion under the heading "Toxicity From Exposure to Contaminants"). However, unlike for nonsensitive species, estimated adverse impacts to a single organism may have a significance for the entire population. Therefore, careful consideration of potential actions to mitigate toxic effects to sensitive species is required. Potential toxicity effects on sensitive species can be better addressed in sitewide or project-specific NEPA analyses tiered from the WM PEIS.

5.4.4.4 Toxicity From Transportation Spills

The ecological impacts of waste transportation accidents were evaluated as consequence assessments that estimated the potential impacts of releases of radionuclides or hazardous wastes under certain spill scenarios but did not include estimates of the probability of these events occurring.

The postulated transportation accident scenario involves a rail shipment spill of waste directly into surface waters of different classes. Assessments were performed for stream-size classes ranging from a small second order stream (e.g., flow rate of a few meters per second) to a tenth order major continental river (e.g., the Mississippi River). For aquatic biota exposed to contaminants released as a result of waste transportation accidents, short-term, acute toxic effects are assumed to occur if the estimated doses exceeded the maximum safe dose of 1 rad per day (rad/day) recommended by the National Council on Radiation Protection and Measurements (NCRP, 1991). Spills of hazardous chemicals were not assessed quantitatively due to the extreme variability in the types and amounts of chemicals that would be shipped. Although it is unlikely that an accident involving wastes with hazardous constituents (LLMW, TRUW, HLW and HW) would involve releases into a surface water body or wetland area, this type of accident could cause adverse impacts to aquatic organisms. The severity of the impact would depend largely on the type of waste involved, the amount of waste released, and the characteristics of the surface water body affected.

Accidents involving wastes contaminated by metals would be unlikely to cause major impacts due to their generally low acute toxicity, and low solubility of most metals in natural surface waters. Clean-up efforts mandated by EPA and DOE regulations would reduce the possibility of any long-term effects. Accidents involving wastes contaminated by low concentrations of organic chemicals would be unlikely to cause major impacts due to the small amount of contaminants present, and the volatile nature of many of these compounds. Accidents involving large releases of liquid organic compounds (e.g., spent solvents) are likely to cause significant mortality of aquatic organisms due to acute effects. Chronic effects are less likely due to mandated clean-up efforts. These impacts would also vary with the amount of dilution provided by the surface water body; large rivers would provide more dilution than small streams or stagnant marshlands.

5.4.4.5 Toxicity From Facility Accidents

Toxicity impacts due to facility accidents on terrestrial and aquatic ecosystems on and near the sites were not specifically evaluated. DOE assumes that facility accidents would affect all or portions of these ecosystems, potentially causing acute and chronic effects to exposed communities. The human health risk assessment of facility accidents provides information on the predicted frequency of occurrence and severity of these accidents. That analysis indicated that for the more severe, lower frequency accidents, human health effects, including acute and chronic illnesses and death would result. Effects on ecosystems exposed during these accidents would likely be of the same severity, at least on a local basis. Emergency response procedures should limit the areal extent of severe effects, especially chronic effects.

5.4.5 Economic Impacts

The economic impacts analysis used changes in disposable income, output (monetary value of industry sales), job-years, and employment. In addition, baseline data were available for disposable income and employment, so percent changes in the baseline income and employment were analyzed at both the regional and national levels.

Economic Impacts in the Host Communities. Expenditures for labor and materials to build and operate waste management facilities were evaluated for effects in terms of job creation, changes in personal income, and changes in economic output in the regional economy at each of the 17 major sites. For these sites, the region of influence (ROI) for economic effects was determined based on the residence patterns of the site employees. In addition to the host county, counties were included in the ROI if they contained 5% or more of the current site workforce. If the total represented by these counties did not represent at least 90% of the total site workforce, counties with progressively lower percentages of site workforce were included until the 90% threshold was met. Contiguous counties were included by exception (DOE, 1993c).

To determine the total regionally based economic effects across all the waste management sites, a parallel analysis was conducted for the minor sites, although these sites are not addressed individually in the impacts chapters. To minimize data and analysis requirements, the ROI for the minor sites consisted of the host and contiguous counties.

DOE recognizes the potential for negative public perceptions associated with its waste management program; for example, real estate property values in the vicinity of a radioactive waste disposal facility may decline, or the region may experience some effect on its ability to attract a diversified business base. However, the extent of such impacts is not amenable to analysis at the programmatic level without specific information on the location of any proposed facility and, thus, has not been included in this PEIS.

Impacts in the National Economy. Changes in National employment, personal income, and economic output were calculated based on complexwide expenditures for labor and materials required to construct and operate all waste management facilities for each waste type under each alternative. National level economic impacts were also estimated on the basis of total expenditures for intersite transportation and (where applicable) commercial treatment and disposal of waste.

Economic Impacts Evaluation. The economic impact analysis assumed that direct expenditures on labor and materials for constructing and operating waste management facilities would lead to subsequent cycles of spending. An initial expenditure by DOE becomes income to the recipient, who in turn spends a portion of the money, thereby increasing income in the economy for the second time. This process of multiple rounds of spending continues until all the money is used for savings, taxes, or the purchase of imported goods.

The first step in the analysis was to estimate general regional economic multipliers, which quantify how responsive the various regional economies and national economy were to changes in the level of expenditures. These economic multipliers quantify the change in employment, personal income, or industry output per unit input of money. Each site ROI and each industry within an ROI had a unique degree of responsiveness to changes in the level of expenditures. General multipliers for employment, personal income, and economic output were developed for 80 industries for the site ROIs and the national economy (DOC, 1992c). A simplifying assumption was made that the average (mean) multiplier was an unbiased and efficient estimator of the 80 separate industry multipliers.

A set of behavioral assumptions was applied in the calculation of multipliers. A national savings rate of 5% of personal income was deducted from the first cycle expenditures. An additional 32.1% was deducted for taxes and benefits. The full economic consequences of waste management activities (construction phase and operations phase) were assumed to continue for an additional 5-year period beyond the end of each phase (Cuthbertson and Nitzsche, 1994).

Economic Impacts Data. The baseline data come from the U.S. Department of Commerce, Bureau of Economic Analysis. The Bureau's "Regional Economic Information System" provides historical data on employment and personal income (DOC, 1992b).

5.4.6 POPULATION IMPACTS

The population impacts analysis evaluated effects associated with any large-scale industrial or public works project, such as the introduction of new workers to the surrounding region or increased demand on services.

5.4.6.1 Population Impacts Evaluation

The ROI for population impacts was the same as the ROI defined for the economic impacts analysis.

Estimates of worker in-migration were derived from predicted labor requirements for the treatment, storage, or disposal facilities proposed under each alternative for each site. Total in-migration to the region surrounding each site was calculated based on the average household size of worker families; calculations for both construction and operations phases were made. The potential for impact on community characteristics and on the provision of social services was derived by comparing the size of potential in-migrating populations with the current regional population (Canter, 1977; Halstead et al., 1984).

Sites experiencing an estimated in-migration greater than 1% of the total 1990 ROI population were considered to have a significant potential for creating change to the social environment. This criterion is based on the assumption of a minimum 1% surplus capacity in public service delivery systems, infrastructure, and other health and welfare services. An increase of less than 1% would also not normally be expected to change the general distribution of demographic characteristics within the population as a whole (e.g., change the character of the population by changing the percentage of the population in a given category such as gender, marital status, etc.). These sites were identified for the analysis of each alternative under each waste type. Additionally, sites with estimated population increases over 0.5% were assumed to have a potential for minor impact to social characteristics and social services and are noted in the waste-type impacts discussions where appropriate. Where labor requirements during construction and operations were insufficient to stimulate a large in-migration to the ROI (less than 0.5%), associated impacts were considered to be unlikely to affect the local social environment.

The analysis assumes that the in-migrating workforce will be distributed throughout the ROI in the same proportions and densities as the current ROI population, since the precise location of any new facilities on a given site and the likely residence location preferences of the new workers are not available at this time. Although this analysis used the 1% population increase as a general guideline in estimating the potential effect of population change on the region as a whole, noticeable effects may occur at much lower levels if new in-migrants would be concentrated in one or two communities, rather than distributed throughout the ROI.

The potential for a rapid or sudden increase in population migration to the region of influence resulting from the cumulative effect of this action when overlapped with other planned or foreseeable projects at the site is a serious consideration for the analysis of site-level impacts associated with this analysis. Population impacts are therefore conservatively assessed to highlight those actions and alternatives that can cause rapid change. This is especially important during the construction phase, when peak periods for multiple projects may cause a sudden sharp increase in temporary employment at the site. Since the actual timing of peak employment periods is not available for this analysis, only a very general discussion is possible at the programmatic level. However, peak period employment is provided in *Waste Management Environmental and Socioeconomic Impacts Methods and Results* as a guide to later site-specific analysis and for local planners in the affected regions (DOE, 1996a).

5.4.6.2 Population Impacts Analysis Data

Statistical descriptions of population and demographic characteristics for the ROI were developed from 1990 U.S. Census data (DOC, 1992a). New workforce estimates were based on the full-time equivalent (FTE) labor requirements developed from the engineering analysis of waste management facilities and waste management activities required at each site for each alternative. Estimates of worker family size were based on 1990 census data for the national average population per household for 1991, or 2.63 persons (DOC, 1992a). The estimate of in-migration was developed by calculating the total number of potential new workers (direct, indirect, and induced) from the engineering analysis estimates, and adjusting it for the estimated percentage of the workforce that might be drawn from the ROI itself (see Appendix C for a discussion of the analytical approach to influences on worker in-migration). Potential in-migration was then estimated on the basis of the remaining percentage of the total workforce anticipated to come from outside the ROI multiplied by average household size.

5.4.7 Environmental Justice

In February 1994, Executive Order 12898, entitled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (FR 1994), was issued. This order directs Federal agencies to achieve environmental justice as part of their missions. As such, Federal agencies are specifically directed to identify, and address as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations.

5.4.7.1 Status of Guidance on Environmental Justice

In addition to describing environmental justice goals, Executive Order 12898 directs the Administrator of the EPA to convene an interagency Federal Working Group on Environmental Justice (referred to as the Working Group). The Working Group is directed to provide guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. The Working Group is also directed to coordinate with each Federal agency to develop an environmental justice strategy, if a strategy is required by the proposed activities. Although the Working Group has not issued final guidance on the approach to be used in analyzing environmental justice, it has issued draft definitions of terms in the *Draft Guidance for Federal Agencies on Key Terms in Executive Order 12898*, dated November 28, 1994. These definitions, with slight modifications, were used in the WM PEIS environmental justice analysis. Further, in coordination with the Working Group, DOE has issued draft internal guidance for the implementation of the Executive Order. Because both DOE and the Working Group are still in the process of developing final guidance, the approach used in this analysis might depart somewhat from whatever guidance is eventually issued.

For the environmental justice assessment, the following Working Group definitions were used:

- **Disproportionately high and adverse human health effects**—Any human health effect from exposure to environmental hazards that exceeds generally accepted levels of risk and affects minority or low-income populations at a rate that appreciably exceeds the rate for the general population. Adverse health effects are measured in risks and rates that could result in latent cancer fatalities and other fatal or nonfatal adverse impacts to human health.
- **Disproportionately high and adverse environmental impacts**—A deleterious environmental impact determined to be unacceptable or above generally accepted norms. A disproportionately high impact refers to an environmental hazard with a risk or rate of exposure for a low-income or minority population that appreciably exceeds the risk or rate of exposure for the general population.

5.4.7.2 WM PEIS Analysis of Environmental Justice Impacts

In order to determine potential environmental justice impacts for this assessment, DOE first identified and mapped the distribution of minority and low-income populations. DOE examined the composition of the population residing within 50 miles of the 17 major sites and then reviewed the human health effects and environmental impacts on the general public associated with alternatives for the five waste types. The review included potential impacts under each of the major disciplines evaluated for the waste-type alternatives, including health risk, air quality, water resources, ecology, economics, population impacts, land use, and infrastructure impacts, which are the sciences pertinent to the identification of the waste-type alternative environmental impacts. Regarding health effects, normal facility operations were examined and evaluated in terms of the risk to the public. The examination of transportation included both normal and potential accident conditions for both truck and rail transportation of the waste types. As described more fully below, these impacts were then examined to determine whether they were expected to be high and adverse. Except as noted below, because the risks to the general population resulting in the 50-mile zone of impact at each site are not expected to be high, DOE would not expect minorities or low-income populations to experience disproportionately high and adverse health effects from the alternatives considered in the WM PEIS.

5.4.7.2.1 *Identification and Mapping of Minority and Low-Income Populations*

For each of the 17 major waste management sites, demographic maps (see Appendix C) were generated through a geographic information system that used 1990 census data available from the U.S. Bureau of the Census. Data were resolved to the census tract group level. A census tract is an area defined for the purpose of monitoring census data that is usually composed of between 2,500 and 8,000 persons. Figures C.4–7 through C.4–40 illustrate census tract distributions for both minority and low-income populations residing within 50 miles of the 17 DOE sites being considered for the management of the five waste types. Native American Tribal lands within 50 miles of each site were also identified and mapped and are included in Appendix C, where applicable, with the minority distribution maps C.4–7 through C.4–23. These maps are based on an analysis of 1990 United States Bureau of the Census Tiger Line files, which contain political boundaries and geographical features, and Summary Tape Files 1 and 3, which contain demographic information (DOC, 1992d,e). (Data from the 1990 Bureau of the Census files are the latest data available on a national level.) Appendix C provides the data definitions and methods used to develop the maps.

A ***minority population*** is a group of people and/or community experiencing common conditions of exposure or impact that consists of persons classified by the U.S. Bureau of the Census as Negro/Black/African-American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, or other nonwhite, based on self-classification by the people according to the race with which they most closely identify. For purposes of this analysis, a minority population consists of any census tract within the 50-mile zone of impact with a minority population proportion greater than the national average of 24.4%. A ***low-income population*** refers to the U.S. Census Bureau data definitions of individuals living below the poverty line. The poverty line is defined by a statistical threshold that considers family size and income (see Appendix C). For purposes of this analysis, low-income population consists of any census tract within the 50-mile zone of impact with a low-income population proportion greater than the national average of 13.1%.

Native Americans. While recognizing the unique Tribal Nation Status, DOE has also included Native Americans as part of the overall regional minority populations when analyzing for disproportionately high or adverse impacts to minorities. Since the interests of Native American groups are unique to each site, the analysis of impacts to these groups and resources is more appropriate to a site-level assessment. This PEIS identifies those sites where recognized Native American groups are present in the region. Where Native Americans do not comprise a recognized group, they are still considered as a part of the site minority population. Known Native American traditional and historic properties are also identified in Chapter 4, The Affected Environment.

5.4.7.2.2 *Review of High and Adverse Health Risks and Environmental Impacts*

The environmental justice analysis presented in each waste type chapter reviewed the findings of the risk assessment for public health effects from proposed waste management activities at each site. Screening criteria (see Appendix C) based on WM PEIS population risk modeling were applied at each site to determine potential high and adverse health effects. Because the WM PEIS human health risk assessment findings indicated that risks to the general population residing in the 50-mile zone of impact at each site would be low, it was reasonable to conclude that no segment of the population, including any minority or low-income populations, would experience disproportionately high and adverse health risks.

5.4.7.2.3 *Subsistence Consumption*

With regard to the impacts analyzed in this PEIS, and in the absence of subsistence consumption data by population subgroups, DOE prepared Table 5.4–5 using the following criteria and assumptions, listed in order of importance, to identify groups of sites that may be near minority and low-income populations potentially engaging in subsistence consumption:

- Proximity of Tribal Lands to DOE sites (the presence of Native Americans near DOE sites is assumed to create a greater possibility of subsistence consumption)
- Distance of the DOE site to major surface water bodies (populations nearer water are assumed to have a greater possibility of subsistence consumption of fish)
- Population density in the 50-mile region of influence around the site (rural residents are assumed to have a greater possibility of engaging in subsistence hunting and fishing)
- Proximity and concentration of minority and low-income populations to DOE sites (higher concentrations of minority and low-income populations are assumed to have a greater potential for subsistence consumption)

The 17 major DOE sites appear in the table in three groups: those with the highest possibility for subsistence consumption, those with intermediate possibilities for subsistence consumption, and those with the lowest possibilities for subsistence consumption. As Table 5.4–6 shows, more rural sites with recognized Native American groups are assumed more likely to engage in subsistence hunting and fishing. These include Hanford, INEL, LANL, RFETS, SNL, SRS, WIPP, and WVDP. Sites of intermediate concern include NTS, ORR, PGDP, and PORTS because of the respective site's rural surroundings, the presence of Native American populations, the presence of minority or low-income populations, or the presence of surface water on site. While sites like ANL and LLNL have a large percentage of minorities, both sites are in urban areas with populations of 8 and 6.3 million, respectively. Because of these factors, ANL and LLNL are listed along with BNL, FEMP, and Pantex as having a lower possibility of populations who principally rely on fish and/or wildlife for subsistence. Subsistence consumption analyses performed for other DOE EISs generally show no high and adverse impacts or are inconclusive. The notable exception

Table 5.4-6. Factors Contributing to the Possibility of Subsistence Consumption of Fish and Wildlife

Site	Federally Recognized Native American Groups[a]	Distance to Major Surface Water Bodies	Population in the 50-Mile Region of Influence (in millions)	Percent Minority (within a 50-mile radius)	Percent of Low-Income Populations
Sites With Higher Possibility of Subsistence Consumption					
Hanford	Yes	On site	0.35	25.8	18.8
INEL	Yes	NA[b]	0.11	10.2	12.5
LANL	Yes	At site boundary	0.27	48.1	13
RFETS	Yes	On site	1.98	19.7	9.8
SNL	Yes	6 miles	0.61	45.1	14.8
SRS	Yes	At site boundary	0.59	37.8	18
WIPP	Yes	NA	0.10	36.9	21.6
WVDP	Yes	On site	1.54	11.6	12.2
Sites With Intermediate Possibility of Subsistence Consumption					
NTS	Yes	NA	0.01	12.8	12.6
ORR	None	At site boundary	0.88	6.1	16.2
PGDP	None	<2 miles	0.50	9.1	19.1
PORTS	None	<1 mile	0.61	3.2	20.8
Sites With Lower Possibility of Subsistence Consumption					
ANL	None	<1 mile	8.03	33.5	11.4
BNL	None	On site	5.26	21.4	5.4
FEMP	None	<1 mile	2.64	13.2	11.8
LLNL	None	NA	6.31	40.9	9.5
Pantex	None	NA	0.27	19.8	15.2

[a] The presence of a Federally recognized Native American group was assumed to be the most important indicator of potential substance fishing and hunting. The remaining factors are listed in descending importance from left to right.
[b] No major surface water bodies within the Region of Influence.

is the Hanford Tank Waste Remediation System EIS, which identified potential disproportionate impacts to Native Americans. These are discussed in Appendix C, Section C.4.7.2.4.

5.4.8 Land Use

The land resources analysis evaluated the potential for waste management alternatives for the five waste types to adversely affect land use at the sites. The evaluation was made by comparing the amount of land required for proposed waste treatment, storage, or disposal facilities with the amount of land designated for future waste management operations in the site development plans for the 17 major sites. If these sites did not have a portion of the site specifically designated for waste operations, the land required for a waste management facility was compared with an estimated amount of land considered suitable for waste management facility development. This estimate was made by subtracting from the total site acreage the known or estimated acreage of land in existing structures, sensitive habitats including wetlands, topographic and surface water features, and other features such as wildlife management areas and cultural resources.

At sites where the land requirement estimated for the proposed waste management facilities constituted 1% or more of designated or suitable land, a potential for impacts was noted in the waste type impacts discussion, and the percent required was listed in a summary table for the site/alternative. The 1% threshold was used as a general impact screening level. DOE assumed that, below the 1% level, significant impacts were unlikely and thus did not analyze these sites further. For sites above the 1% threshold, DOE assumed that there may be a potential for significant impacts. Additional analysis for sites above the 1% threshold includes the severity of impacts depending on the percentage required of the available land and an indication of the likelihood of conflicts with land uses adjacent to the site. If the land requirement for proposed facilities exceeded the amount of land designated or suitable, significant land use impacts were considered likely. The analysis also indicated whether the description of future uses given in a site's current development plans would potentially conflict with the uses proposed under the waste type alternatives.

The analysis also assumes that, regardless of the site, waste-type, or alternative, waste management facilities would not be located in the 100-year floodplain. If it is determined in sitewide or project-level NEPA analyses that the facilities are "critical actions" under the DOE floodplain regulations, they would not be located in the 500-year floodplain. Compliance with the requirements of Executive Order 11988, Floodplain Management (Executive Order 11988, 1977) and 10 CFR 1022, Compliance with Floodplain/Wetlands

Environmental Review Requirements, would be examined in detail in these sitewide or project-level NEPA reviews.

5.4.9 INFRASTRUCTURE IMPACTS

The infrastructure impacts analysis evaluated the impacts of the alternatives on onsite and offsite infrastructure by comparing the resource requirements of building and operating proposed waste treatment, storage, and disposal facilities to existing capacities of onsite infrastructure systems and to current offsite demand. The infrastructure resources considered in this evaluation include: (1) water supply (potable and process), (2) wastewater treatment facilities (sanitary and process), (3) electrical power supply, and (4) onsite transportation infrastructure. The impacts assessment evaluated the separate effects of the construction phase and the operations phase of each alternative for each of the waste types.

5.4.9.1 Onsite Impacts

The effects of the alternatives on each site's onsite infrastructure systems (except transportation) were assessed quantitatively by comparing the new demand under each alternative to the existing maximum capacity of the site's infrastructure. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current demand for each resource category.

DOE assumed that new resource requirements less than 5% of current capacity would have minor or negligible impacts. Increases in requirements of 5% or greater were assumed to have the potential to cause moderate or major impacts, and were further evaluated on a site-by-site basis. An increase of 5% or greater that, when added to current use, caused total demand to exceed 90% of maximum available capacity was assumed to have a major impact. These percentages were selected as a conservative approach to alert decisionmakers to the potential for significant impacts.

Onsite transportation impacts were evaluated by comparing new onsite employment to existing site employment. New employment totals of less than 5% of current totals were assumed to have negligible or minor impacts. Increases in employment of 5% or greater were assumed to have the potential to cause moderate impacts, and increases of 15% or greater were assumed to have potentially major impacts. As with the new project demands, these percentages were selected in order to identify the potential for significant impacts.

5.4.9.2 Offsite Impacts

New resource requirement demands on offsite infrastructure for each alternative were compared with estimated current demand. New offsite demands under the alternatives was based on population increases from the social impacts analysis. Similarly, the estimated current demand was based on 1990 regional population data from the social impacts analysis. Evaluation of the transportation effects on infrastructure resources was based on forecasted increased traffic from employees directly or indirectly associated with the alternatives, based on population changes developed by the social impacts analysis.

New offsite demands of less than 5% of current demand were assumed to be negligible or to result in minor impacts. Increases in demand of 5% or greater were assumed to have the potential to cause moderate impacts, and increases of 15% or greater were assumed to have potentially major impacts. These conservative assumptions allow DOE to identify the potential for significant impacts.

The following assumptions were made in the evaluation of infrastructure impacts:

- Wastewater treatment demand was assumed to be equal to water use. Sanitary sewage and industrial wastes are derived principally from the water supply (McGhee, 1991), and the amount of water used by a city is a good indicator of the amount of sewage that will be generated (Viessman and Hammer, 1985). Where actual data on municipal rates of wastewater were unavailable, water supply records were used to estimate wastewater flow (Metcalf & Eddy, 1991).
- Existing capacity indicates either the capacity of the onsite infrastructure or the allocation to the site by an offsite infrastructure system. Where maximum capacity information was not available, it was assumed that a comparison of new demand to existing demand is an acceptable indicator of potential impacts.
- Offsite impacts to infrastructure were assumed to be limited in aerial extent to the ROI used in the socioeconomic analyses.

5.4.10 CULTURAL RESOURCES

The cultural resources addressed in the WM PEIS analysis include prehistoric and historic resources, and Native American resources. Paleontological resources, though not cultural in origin, are also included because of their recognized value and similar need for protection.

Prehistoric and Historic Properties. A "historic property" is an archeological site, standing structure, or traditional cultural property that is listed or is potentially eligible for listing on the National Register of Historic Places. Requirements for the assessment of historic properties are met through compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC 470 *et seq.*), and with implementing regulations contained in 36 CFR 800.

Federal agencies are required to determine the effect that proposed actions may have on significant historic properties within the defined area of potential effects. The "area of potential effects" usually comprises the physical limits of disturbance or alteration that will result from implementing the proposed actions, such as construction or operation of a waste management facility. The presence or absence of historic properties within the area of potential effects (36 CFR 800.4) is then determined.

An adverse effect is assumed whenever the integrity of the cultural resources' property location, design, setting, materials, workmanship, feeling, or association may be diminished. Adverse effects on historic properties include, but are not limited to: (1) physical destruction, damage, or alteration; (2) isolation of the property or alteration of the character of its setting; (3) introduction of visual, audible, or atmospheric elements that are out of character; (4) neglect resulting in deterioration or destruction; and (5) transfer, lease, or sale of the property (36 CFR 800.9.b.1–5). If no cultural resources are identified that are eligible or potentially eligible for the National Register of Historic Places, then, in consultation with the State Historic Preservation Office and in the absence of any other significant cultural or Native American resources, it can be assumed that the project will have no effect on historic properties and the action may proceed.

Native American Resources. Native American resources refer to structures, regional locations, natural features, native plants, objects, and other materials considered to be of value to contemporary Native American groups for traditional, religious, or ceremonial purposes. Resources involve geographic locations and their settings such as: burial grounds; sacred sites or areas; materials for producing sacred objects and traditional implements; botanical, biological, and geological resources of ritual importance; and natural elements. Impacts to these areas include both direct physical impacts (e.g., destruction, damage, or reduced access to sacred sites preserved in their natural settings) and indirect social and economic effects (e.g., disruption or intrusion on religious beliefs and cultural practices of tribal peoples closely connected to the earth and its resources). Several laws and Executive Orders are specifically applicable to the protection of Native American resources, including the American Indian Religious Freedom Act of 1978 (42 USC 1996 *et seq.*), the Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001 *et seq.*), and Executive Order 13007 regarding sacred sites. Implementation of these statutes as well as 36 CFR Part 800 depends on establishing government-to-government consultation with American Indian tribes that have treaty and traditional interests in DOE lands.

Paleontological Resources. Paleontological materials and features are the physical remains of life forms (fossils) from a former geologic age. These include the remains of animals, plants, or trace fossils, such as impressions, burrows or tracks. Although paleontological resources are not treated with the same level of specificity as archeological or historic properties, they are addressed in several Federal statutes, such as the Federal Land Management Policy Act of 1976 (43 USC 1701 *et seq.*).

Cultural Resources Approach. Cultural resources are not uniformly distributed across the landscape but are located with reference to physical and human geography. Therefore, the actual physical location selected for the construction of a facility is the most important factor in determining the nature and extent of any potential impact. Because the specific locations of proposed waste treatment, storage, or disposal facilities at any of the DOE sites are not being selected in the WM PEIS, potential impacts to cultural resources cannot be thoroughly analyzed in this programmatic document. DOE will evaluate the potential impacts to cultural resources, including Native American resources, in sitewide or project-specific NEPA reviews prepared to evaluate alternative locations on a particular site where a waste management facility should be constructed.

Table 4.3–8 lists the known archaeological resources for each site. Only ANL-E, RFETS, and SNL-NM have been completely surveyed. With one exception (SNL-NM), wherever surveys have been conducted archaeological sites have been found. At all but two DOE sites (RFETS and WVDP) where archaeological sites have been found, at least some of the archaeological sites have been found to be eligible for the National Register of Historic Places. Even where surface surveys have been completed, however, the possibility of significant archaeological remains that have left no surface indicators cannot be excluded. The extent to which these archaeological resources may be affected by a given alternative can be assessed only when specific construction locations have been determined. Once identified and evaluated, a plan for the management of affected cultural resources must be developed in consultation with the relevant SHPO and any Native American group whose traditional resources may be affected. Management plans include provisions for protection, mitigation (often excavation), and access to cultural resources, as appropriate.

5.4.11 Geology and Soils

As indicated in Chapter 4, Affected Environment, DOE's review of the geology and soils at the 17 major sites indicated that it is unlikely that impacts to these resources would affect the selection of alternatives for any waste type. For this reason, the impacts analysis in the waste-type chapters do not address geology and soils.

While geology and soil characteristics are important determinants of where on a particular site a facility could be located, such determinations are not being made at this time. The exact location of waste management facilities at selected sites will be the subject of sitewide or project-level NEPA reviews. For the DOE sites that are candidates to host waste management facilities, the land use impacts analysis determined whether there is sufficient acreage available to allow a choice among several locations.

Most of the DOE sites are in stable geologic areas. However, seismic characteristics of the sites being considered for waste management facilities were taken into account in the health risk assessment by evaluating potential accident scenarios in which exposure to chemical or radiological constituents of the waste might occur.

An analysis of soil erosion is necessarily site-specific and can be mitigated by site-specific selection processes. Similarly, the assessment of the potential to deny access to mineral resources will be deferred until sitewide or project-level NEPA documents are prepared.

5.4.12 Noise

Noise impacts to workers were not examined in the WM PEIS, because hearing protection would be provided to all WM workers as required by OSHA regulations, and noise impacts are especially dependent on the WM technologies employed. In addition, noise from the construction and operation of waste management facilities, and increased vehicle traffic may cause adverse impacts to the offsite public and wildlife. Because waste management facilities will be placed on industrial type sites and added traffic will be largely on high-volume corridors, these activities should not substantially increase the general ambient noise levels. In certain cases, however, sensitive receptors may be affected. These localized effects were not evaluated in this PEIS because the specific locations of any new activities relative to the locations of sensitive noise receptors at the sites cannot be accurately predicted. Since the WM PEIS will not be selecting the locations of the WM facilities, nor the technologies to be employed, noise impacts cannot be evaluated at this time, but will be considered in future sitewide or project-specific NEPA reviews.

5.4.13 Cumulative Impacts

In addition to the environmental impacts associated with each alternative under each waste type, this document analyzes the cumulative impacts of siting one or more waste management facilities for one or more waste types at specific sites. These cumulative impacts include not only the impacts of potentially managing more than one waste type at a site, but also the "past, present, and reasonably foreseeable future actions" at that site (40 CFR 1508.7).

Considering five waste types, the four alternative categories comprising 36 Alternatives, and 17 potential sites, numerous combinations of possible alternatives cumulative impacts could be analyzed. Performing all possible cumulative impact analyses and including those analyses in the WM PEIS is neither warranted nor desirable.

In order to accomplish a reasonable analysis framework, DOE displays "minimum" and "maximum" impact alternatives for each DOE site. The WM PEIS indicates which combination of alternatives would impose the least cumulative impacts on that site and which would impose the most cumulative impacts. All other combinations of alternatives applicable to that site would fall somewhere between the minimum and maximum impacts. Impacts not addressed in the WM PEIS that have occurred, are occurring, or will occur at the sites are also included in the cumulative impact analyses (these non-WM PEIS activities are assumed to be constant for all the combinations applicable to a specific site).

In addition, quantitative information regarding the impacts from each alternative for each waste type at a particular site is available from tables included in Volume II of the WM PEIS. From those tables, it is possible to quantitatively estimate the cumulative impacts of any particular combination of alternatives. Guidance for performing that calculation is provided in Chapter 11.

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CHAPTER 6
Impacts of the Management of Low-Level Mixed Waste

Chapter 6 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for low-level mixed waste (LLMW). This chapter provides information on existing and anticipated LLMW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to LLMW characteristics, the treatment and disposal technologies considered, and the rationale for selecting the specific sites analyzed under each alternative. The chapter discusses the health risk, environmental impacts, and costs of the alternatives, and provides a comparison of the alternatives.

The methods used to evaluate impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the LLMW analysis are contained in the Technical Report entitled "Low-Level Mixed Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports provided in Chapter 15.

6.1 Background

6.1.1 DEFINITION AND ORIGIN OF LLMW

- *LLMW contains both radioactive and hazardous components.*
- *LLMW is generated, projected to be generated, or stored at 37 DOE sites as a result of research, development, and production and dismantlement of nuclear weapons.*
- *Waste management activities will require management of an estimated 219,000 cubic meters of LLMW over the next 20 years.*
- *DOE must select treatment and disposal sites for LLMW.*

Low-level mixed waste contains Resource Conservation and Recovery Act (42 USC 6901 *et seq.*) (RCRA)-controlled substances and is radioactive. It is managed according to RCRA requirements because of its RCRA hazardous waste characteristics and according to the Atomic Energy Act (AEA) (42 USC 2011 *et seq.*) because of its radioactive components. The hazardous component of this LLMW is subject to either (1) EPA regulations promulgated under RCRA, (2) EPA regulations for polychlorinated biphenyls (PCBs) promulgated under the Toxic Substance Control Act (TSCA), or (3) State hazardous waste regulations promulgated under RCRA. LLMW has been generated by DOE as a result of research, development, and production of nuclear weapons; however, LLMW generation from nuclear weapons production and nuclear research is declining.

6.1.2 Volumes and Locations

LLMW is generated, projected to be generated, or stored at 37 DOE sites. According to DOE estimates, waste management activities will require management of approximately 219,000 cubic meters of LLMW over the next 20 years. The total volume of wastes after treatment requiring disposal will be about 72,000 cubic meters. Additional LLMW generated by environmental restoration activities is discussed in Section 6.15.

Table 6.1–1 presents the estimated total volume of LLMW from waste management activities at each of the 37 LLMW sites. (Details of the amounts and characteristics of LLMW are provided in ANL [1996].) Both inventory wastes and 20-year projected wastes (1994–2013) are provided. The *Mixed Waste Inventory Report* (DOE, 1994) was used for all LLMW inventories and generation rates, except for Colonie, ETEC, and RFETS, which use late 1994 site estimates, and ANL-E and NTS, which use the *Mixed Waste Inventory Report* (DOE, 1995c). Where MWIR totals were provided for only 5 years, waste volumes were extrapolated to provide waste totals for the 20-year analysis period. PCB wastes have been included both in the data presented in Table 6.1–1 for each of the sites and in the analysis of impacts presented later in this chapter. Information on waste volumes updated from the Draft WM PEIS was used for ANL-E and NTS (DOE, 1995c). The analysis presented in the WM PEIS is based on this newer information for those two sites. A more complete discussion on data used in the WM PEIS analysis is presented in Appendix I.

This WM PEIS analyzed the impacts of managing LLMW at 16 major sites (WIPP, another major site, will not have LLMW). In general, the remaining 21 LLMW sites have very small existing and projected volumes and therefore were not considered major sites. Figure 6.1–1 presents the total LLMW volumes at the 16 major sites considered under the LLMW alternatives.

Owing primarily to improvements in waste characterization, projected waste volumes and inventories of LLMW have changed since the analysis of these wastes was carried out for the WM PEIS. A discussion of these changes in the waste volume estimates at each site, including updates taken from newer databases, is found in Appendix I. This appendix also identifies criteria for reanalyzing sites using the more recent data and describes DOE's conclusions about the need to analyze the more recent data for specific sites.

Table 6.1-1. Low-Level Mixed Waste Volumes (cubic meters)

Site	Inventory	20-Year Projected Generation	Estimated Inventory Plus 20 Years Generation
1. Ames Laboratory (Ames)	0.3	0.1	0.4
2. Argonne National Laboratory-East (ANL-E)[a]	34	125	159
3. Battelle Columbus Laboratories (BCL)	0	0.1	0.1
4. Bettis Atomic Power Laboratory (Bettis)	32	16	48
5. Brookhaven National Laboratory (BNL)	85	110	190
6. Charleston Naval Shipyard (Charleston)	0.3	3	3
7. Energy Technology Engineering Center (ETEC)[a]	3.7	13	17
8. Fernald Environmental Management Project (FEMP)	2,600	48	2,600
9. General Atomics (GA)	43	0.4	43
10. Grand Junction Project Office (GJPO)	0.6	0.9	1.5
11. Hanford[b]	3,100	33,000	36,000
12. Idaho National Engineering Laboratory (INEL)	25,000	9,600	35,000
13. Kansas City Plant (KCP)	0.8	0	0.8
14. Knolls Atomic Power Laboratory (KAPL)	3.1	220	220
15. Laboratory for Energy-Related Health Research (LEHR)	4	3	7
16. Lawrence Berkeley Laboratory (LBL)	6	270	280
17. Lawrence Livermore National Laboratory (LLNL)	230	4,100	4,300
18. Los Alamos National Laboratory (LANL)	670	2,100	2,800
19. Mare Island Naval Shipyard (Mare Is)	10	42	52
20. Mound Plant (Mound)	76	4	80
21. Nevada Test Site (NTS)[a]	300	2,700	3,000
22. Norfolk Naval Shipyard (Norfolk)	0	6	6
23. Oak Ridge Reservation[c] (ORR)	26,000	33,000	59,000
24. Paducah Gaseous Diffusion Plant (PGDP)	600	0	600
25. Pantex	130	560	690
26. Pearl Harbor Naval Shipyard (Pearl H)	2	4	6
27. Pinellas	0.01	0.01	0.02
28. Portsmouth Gaseous Diffusion Plant (PORTS)	7,500	25,000	33,000

Table 6.1–1. Low-Level Mixed Waste Volumes (cubic meters)—Continued

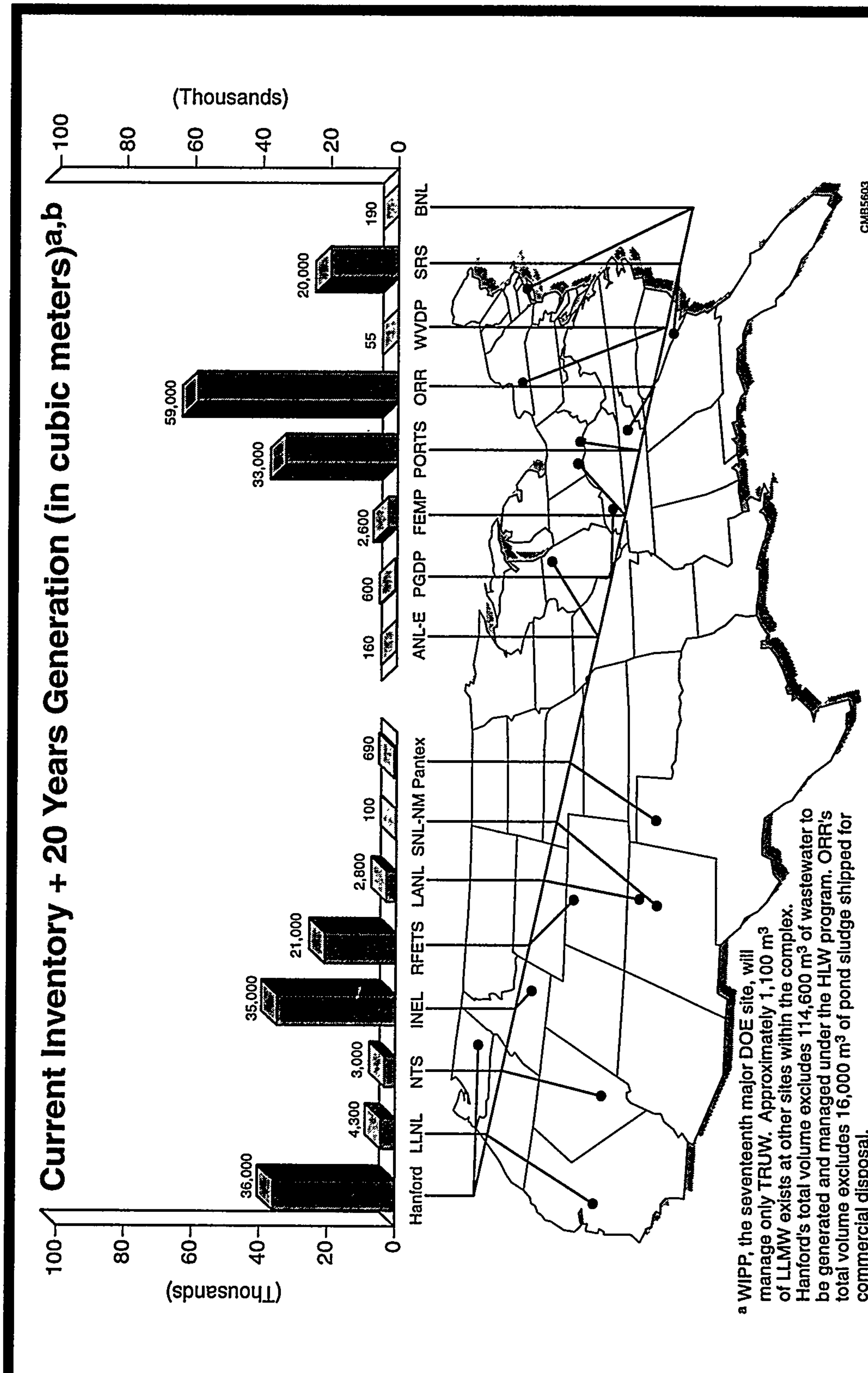
Site	Inventory	20-Year Projected Generation	Estimated Inventory Plus 20 Years Generation
29. Portsmouth Naval Shipyard (Ports Nav)	0.4	0.8	1
30. Princeton Plasma Physics Laboratory (PPPL)	0	0.02	0.02
31. Puget Sound Naval Shipyard (Puget So)	62	170	230
32. RMI Titanium Company (RMI)	22	7	29
33. Rocky Flats Environmental Technology Site (RFETS)[a]	8,300	13,000	21,000
34. Sandia National Laboratories-New Mexico (SNL-NM)	69	33	100
35. Savannah River Site (SRS)	6,600	13,000	20,000
36. University of Missouri (UofMO)	0.4	1.7	2
37. West Valley Demonstration Project (WVDP)	23	32	55
Total Complex	82,000	137,000	219,000

Note: Volume data are rounded from field estimates and columns do not add. Waste projections above, used for the WM PEIS analysis, are based on 1994 and 1995 data and may vary from latest site estimates. Updated inventories and waste generation rates are summarized in Appendix I. Variances include reduced LLMW projected at BNL (10 m^3 inventory and 30 m^3 projected generation versus the 85 m^3 and 110 m^3 shown above). Wastes transferred to WM from Environmental Restoration (ER) are not included in this table. A discussion of these wastes is included in Section 6.15 and Appendix B.
[a] Updated information on waste volume was used for ANL-E and NTS (DOE, 1995c). Other shaded cells indicate editing for round-off adjustments and other minor inaccuracies.
[b] Total volume excludes 114,600 m^3 of wastewater to be generated and managed under the high-level waste (HLW) program.
[c] Total volume excludes 16,000 m^3 of grouted pond sludge that is being shipped to commercial disposal.
Source: DOE (1994 and 1995c).

6.1.3 Existing and Planned Facilities Available at DOE Sites

DOE identified existing and planned LLMW facilities to establish the baseline capacities for LLMW treatment and disposal at major sites, and to determine the need for new or expanded facilities. Some facilities that are not currently operating were considered to be in existence for the analysis, based on the assumption that they could become operational if required. Planned facilities include only those facilities for which a Title II design has been initiated.

Analysis in the WM PEIS assumes use of existing and planned facilities until their capacities are met. If additional capacity is needed, use of new conceptual facilities is assumed. These conceptual facilities provide the difference in treatment, storage, and disposal capacity between the baseline reported in Table 6.1–2 and what is necessary to manage the source term which a given site would receive under any



[a] WIPP, the seventeenth major DOE site, will manage only TRUW. Approximately 1,100 m^3 of LLMW exists at other sites within the complex. Hanford's total volume excludes 114,600 m^3 of wastewater to be generated and managed under the HLW program. ORR's total volume excludes 16,000 m^3 of pond sludge shipped for commercial disposal.

[b] Updated inventories and waste generation rates are summarized in Appendix I.

Source: DOE (1994).

Figure 6.1–1. Low-Level Mixed Waste at the 17 Major Sites

Table 6.1–2. Capacities of Existing and Planned LLMW Facilities at Major LLMW Sites[a]

Site	Treatment (m³/yr)			Storage (total m³)	Disposal (m³/yr)	
	Aqueous Treatment	Grout Solidification	Incineration	LLMW Container Storage	Engineered Disposal	Shallow Land
ANL-E[b]	47			101		
BNL				335		
FEMP	24,627					
Hanford[c]	120 100,000*	15,360		24,837		1,000[d]
INEL	47,472 3,921*	2,765	2,300	226,240		
LANL				28,541		
LLNL	6,822 147,000*			2,555		
NTS	3,000			3,000		12,648*
ORR	202,808	[illegible]	13,500	42,890		
Pantex		370		1,270**		
PGDP	156			2,719		
PORTS	84,528			7,370		
RFETS	82,785	27,178		17,695		
SNL-NM		1		4,101		
SRS	501,500	40,000 208*	8,200*	13,760	6,800	

Notes: * = planned capacity; ** = permitted capacity. A blank indicates that a site does not perform the specified treatment or disposal operation. No onsite wastewater or wastewater treatment capacity at BNL and SNL-NM sites.
[a] The capacities of these existing and planned units may be divided among several waste types in accordance with site plans.
[b] Onsite reactive metals recovery capacity is 40 m^3/yr.
[c] Onsite reactive metals recovery capacity is 690 m^3/yr.
[d] Original disposal rate was estimated by dividing the planned total capacity of 10,000 cubic meters by 10 years of treatment operations. Trenches 31 and 34 have been constructed with an estimated total capacity of 42,000 cubic meters.

Source: INEL (1995b).

given alternative. Conceptual facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). Where necessary for analysis, an assumption was made that the impact of existing facilities essentially reflects the impact of conceptual facilities. Table 6.1–2 lists the LLMW existing and planned facility capacities at major sites considered in the WM PEIS analysis (INEL, 1995b). Wastewater treatment is the most prevalent treatment capability for LLMW; however, some capabilities for grout solidification, thermal treatment, mercury separation, lead recovery, and reactive metals recovery exist at a limited number of sites. As the table illustrates, two principal methods of disposal are shallow land burial and disposal in engineered facilities, such as concrete vaults.

Both types of LLMW disposal facilities assumed in the WM PEIS were designed to meet all applicable RCRA disposal requirements.

6.2 Analytical Methods and Assumptions

Reported LLMW volumes and facilities were used to analyze the human health risk, environmental and socioeconomic impacts, and costs associated with each of the LLMW alternatives. In addition to examining the total waste volumes and existing LLMW capabilities, DOE identified the chemical and radiological characteristics of LLMW to define treatment and disposal requirements. The LLMW characteristics were used in determining the LLMW alternatives, including location and treatment methods, and in forming the basis for the risk and impacts analyses. The specific LLMW assumptions relating to facilities, treatment and disposal technologies, and transportation are discussed below.

6.2.1 CHARACTERISTICS

6.2.1.1 Physical/Chemical

The challenge in managing LLMW arises from its dual nature: it contains RCRA-classified hazardous components (or characteristics) and it is radioactive. The various physical states (e.g., solids, liquids) of the waste and the presence of friable asbestos fibers and polychlorinated biphenyls (PCBs) pose additional challenges. The MWIR categorized more than 2,000 individual DOE LLMW streams. To define required treatment and disposal technologies, DOE categorized the waste streams into treatment groups, and further condensed those groups based on common physical/chemical characteristics. These characteristics dictate what types of treatment are necessary at each site. Further, emissions from selected treatment technologies are a function of input wastes and their quantities and characteristics, as well as the selected technologies. The waste treatment groups were further subdivided into 23 treatment categories.

Thus, for purposes of analysis, DOE examined five LLMW treatment groups: wastewater, organic liquids, solid process residues, soils, and debris wastes. Figure 6.2–1 illustrates the general treatment flow for each physical waste form (ANL, 1996). Additionally, DOE assigned consistent chemical profiles to identify the composition and concentration of 16 RCRA-hazardous chemical constituents expected to be present in each waste type. The RCRA hazardous constituents included are arsenic, barium, cadmium, chromium, lead, mercury, silver, selenium, cyanides, methylene chloride, soluble hydrocarbons (e.g., ketones), insoluble hydrocarbons (e.g., toluene), chlorofluorocarbons, and 2-, 3-, and 4-chlorinated organic solvents. One additional waste treatment group, special wastes, is not included in this analysis because these wastes each require specialized treatment technologies outside of the scope of the treatments identified in the WM PEIS. The special wastes represent a minor component, less than 2% of the LLMW volume.

6.2.1.2 Radiological Profiles

Because LLMW is both hazardous and radioactive, DOE also identified the radiological characteristics that impose special treatment and handling requirements and, ultimately, help determine emissions, risks, and impacts. Although the MWIR did not provide detailed data on radiological concentrations within the LLMW streams, radiological profiles were assigned based on waste origin. After categorizing the waste into the physical/chemical treatability groups, a site radiological profile was determined and assigned to each treatability group at the site, using an appropriate mix of radionuclides from six distinct radiological categories. The six radiological categories are presented in Table 6.2–1 (ANL, 1996; DOE, 1992).

DOE used the radiological categories to identify the radionuclides at each site that might present a risk to human health or the environment. For example, waste classified as a fission product would contain radionuclides such as cesium-137 or strontium-90, whereas cobalt-60 is commonly associated with waste generated from induced activity (from a reactor) and would most likely occur only at sites handling induced activity wastes, such as nuclear reactor components. Additionally, each radionuclide has a different decay

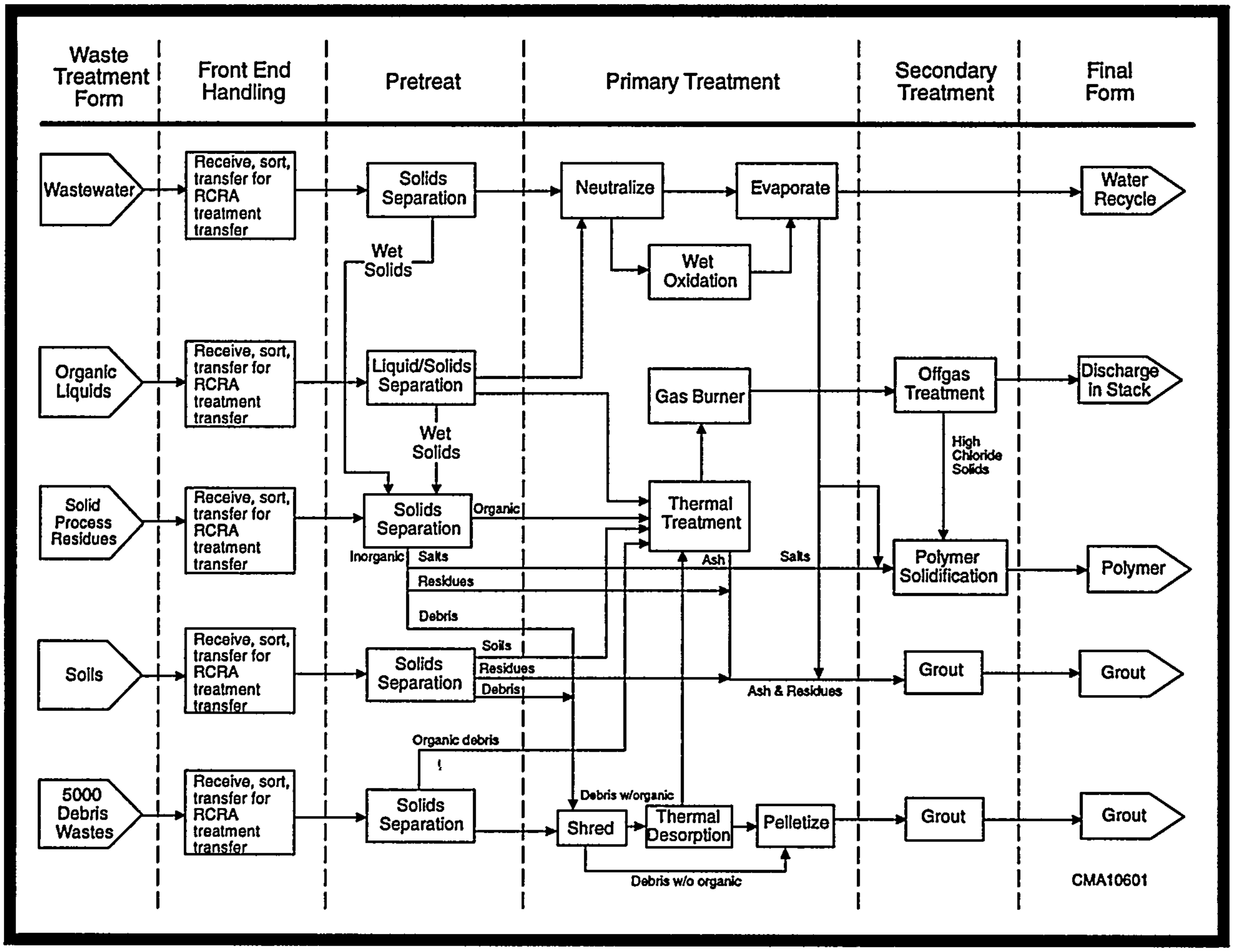


Figure 6.2–1. WM PEIS LLMW Flow Diagram

rate (or half-life) that dictates the persistence of the radioactivity for a specific waste stream at a given site. Over time, radioactive decay reduces the level of radioactivity of a material. For the WM PEIS analysis, decay rates were considered and levels of activity were adjusted to reflect more accurately the expected radiological profiles and doses at the time of treatment.

After the radiological categories of the waste streams were identified, LLMW had to be categorized as either contact-handled (CH) or remote-handled (RH), based on the level and type of radioactivity emitted. These handling categories determine the required level of protective shielding necessary to store and process the waste safely. CH waste containers can be handled directly by humans, whereas RH waste requires extra shielding and sometimes the use of robotics. DOE analyzed CH and RH LLMW separately in the WM PEIS to account for their different treatment and disposal requirements.

Table 6.2-1. Six LLMW Radiological Profiles

Category	Description
Uranium/thorium	Waste material primarily containing the naturally occurring radioactive elements of uranium or thorium
Fission products	Waste containing radioactive isotopes (e.g., cesium-137 and strontium-90) that result when a heavy nucleus is split
Induced activity	Waste that contains elements that were initially not radioactive, but became radioactive as a result of absorbing neutrons (e.g., cobalt-60)
Tritium	Waste material containing trace amounts of tritium (a synthetically produced radioactive isotope of hydrogen)
Alpha	Waste materials contaminated with alpha-emitting (helium nuclei) radionuclides not listed under uranium/thorium or low levels (less than 100 nCi/g) of transuranic isotopes
Other	Waste material that is combined or undefined

DOE further categorized LLMW by the type of radiation it emits. Radioactive materials emit alpha, beta, and gamma radiation. The LLMW analysis separately analyzed alpha-emitting waste, which contains significant quantities of plutonium and other elements whose atomic weights exceed that of uranium. These wastes require special containment and management because of the health threat posed by alpha particles if inhaled.

6.2.2 Technologies and Treatment Processes

DOE designed LLMW treatment systems based on the physical, chemical, and radiological characteristics of each treatment group. An approved treatment method recognized by the U.S. Environmental Protection Agency (EPA) was selected to process each treatability group. Most treatment facilities were assumed to be fixed facilities for LLMW. However, DOE also considered the use of mobile treatment facilities that could be moved from site to site to treat the small amounts of waste that exist at most of the 37 LLMW sites.

LLMW is treated by one or more treatment processes (or “modules”). Individual modules were linked together to form a complete treatment flow process for each treatability group and adjusted for the chemical and physical type of waste. The emissions and impacts were calculated from each module and then added to help determine the overall impacts from each treatment process at a site. In general, each waste stream receives some front-end handling (e.g., sorting), pretreatment (e.g., separation), primary treatment (e.g., organic destruction and wastewater treatment), and secondary treatment, which transforms the waste into a final form suitable for disposal. Identical treatment flowsheets were used for each site to compare impacts, varying only the waste composition, throughput (based on volume), and site-specific environment.

DOE considered a variety of treatment methods and processes for LLMW consistent with the LDRs given in 40 CFR Part 268. For the difficult-to-treat LLMW containing organic material, two thermal treatment methods were analyzed: incineration, which EPA considers the best demonstrated available technology for organic waste; and thermal desorption, which bakes the wastes at temperatures lower than those used in incineration. An alternate treatment process that replaces thermal treatment (incineration and thermal desorption) with washing technologies was also analyzed and is available in a separate technical report (DOE, 1996). Table 6.2–2 presents the standard treatment steps assumed for both LLMW thermal and alternative organic treatment technologies (ANL, 1996a). The waste volumes in Table 6.1–1 contain small amounts of LLMW that require special treatment not covered by the treatment trains represented in Figure 6.2–1. Such LLMW is not analyzed in the WM PEIS.

The WM PEIS treatment steps may not reflect the treatment flow for specific waste streams at individual sites. Rather, DOE used generic treatment processes that have broad applicability to the LLMW sites, could provide consistent analysis among the sites, and could bound the impacts resulting from activities proposed in site-specific reports or in the site treatment plans (STPs) (and the equivalent *Report on the Hanford Site Land Disposal Restrictions for Mixed Waste* [Black, 1992–1995]) developed under the Federal Facility Compliance Act (FFCAct).

For both technologies, two types of disposal were considered: engineered disposal and shallow land burial. Engineered disposal facilities for LLMW are concrete structures with collection systems to prevent leaks into the environment. They are usually located above the natural grade of the land. Shallow land burial facilities are generally shallow earthen ditches.

With regard to privatization of DOE treatment, storage, and disposal (Sections 6.4 to 6.14), it is assumed that the environmental impacts will be essentially the same for the private versus the DOE approach, providing the facilities are located near or in similar locations to those analyzed within this document.

Table 6.2–2. Treatment Steps for LLMW Thermal and Alternative Organic Treatment Technologies

Treatment Steps	Base Technology Option (Thermal)	Alternative Organic Technology Option (Washing)
FRONT-END ↓	Receive, sort, & transfer	Receive, sort, & transfer
PRETREATMENT PROCESS ↓	Separate solids from liquids	Separate solids from liquids
PRIMARY TREATMENT PROCESS ↓	Neutralize and evaporate aqueous liquids, with wet oxidation of solids; thermally treat combustible liquids, solids, & off-gases; noncombustible solids, including ash, and solids from soils and debris are solidified; special treatments for recovery of mercury and lead, and for inherently hazardous materials	Neutralize and evaporate aqueous liquids, with wet oxidation of solids; organic destruction process for organic liquids; separate wash modules for sludges, soil, and debris; special treatments for recovery of mercury and lead, and for inherently hazardous materials
SECONDARY TREATMENT ↓	Recycle water from evaporation; treat off-gases before discharge; oxides from special treatment solidified	Recycle water from evaporation; treat off-gases before discharge; recycle solvents, including water, from washing of solids
STABILIZATION OF SOLIDS ↓	Grout solids from treatment; stabilize in polymer salts not suitable for grouting	Grout solids from treatment; stabilize in polymer salts not suitable for grouting
BACK-END HANDLING ↓ TO DISPOSAL	Prepare stabilized solid waste for shipment for storage and/or disposal; hold recovered metal and mercury for reuse	Prepare stabilized solid waste for shipment for storage and/or disposal; hold recovered mercury for reuse

6.2.3 WM PEIS ASSUMPTIONS: FACILITIES, TREATMENT, DISPOSAL, AND INDEFINITE STORAGE

Although DOE used LLMW volumes and existing facilities from well-documented data sources, the analysis of the alternatives required DOE to make additional assumptions. In addition to the estimating and extrapolating techniques used to identify the radiological and chemical characteristics of LLMW, the following general assumptions relating to LLMW facilities, treatment, disposal, and indefinite storage under the No Action Alternative, helped further define specific actions and operating parameters under each alternative.

Facilities

- All LLMW facilities are designed to treat waste to meet RCRA requirements.
- New facilities will be fully operational after a 10-year period of construction.
- LLMW currently in inventory (sometimes referred to as "legacy waste") plus annually generated waste during the period of construction will be treated during the 10-year period after construction (called a "work-off" period). After the designated work-off period, LLMW is assumed to be treated as it is generated on an annual basis; however, this was not analyzed in the WM PEIS.
- In the LLMW analysis, each site is assumed to build and operate facilities with capacities sufficient to handle only LLMW. This avoids linking the results of one waste type to decisions not yet made in another and results in conservative estimates of risk, cost, and impacts. However, the alternatives were structured to accommodate locating LLMW and LLW facilities at the same site to more accurately reflect the reality of coordinated treatment and disposal. Chapter 11 discusses the cumulative effects for sites hosting more than one waste type facility.

Treatment

- Wastewater treatment activities continue at every site for every alternative, since wastewater is difficult to transport but not to treat. However, residues resulting from wastewater treatment were assumed to be shipped for final treatment under all alternatives, except No Action. (Under the No Action Alternative, the residues are placed in storage for the 20-year analysis period. Sites with no LLMW wastewater treatment facilities, such as the Pantex Plant and LANL, are assumed to grout the aqueous waste and place it in onsite storage for the remainder of the analysis period).
- Under all alternatives, facilities are assumed to be designed to treat LLMW to meet land disposal restrictions (LDRs) using similar treatment modules at all sites. In addition, DOE scaled the treatment

facilities to the smallest size appropriate for treating all LLMW within the 10-year work-off period. Mobile treatment units are used for small waste streams under certain volume levels.

Disposal

- Two types of disposal were analyzed in the WM PEIS: engineered disposal and shallow land burial. However, when disposing of smaller quantities of waste (i.e., less than 700 cubic meters per year), aboveground silos were assumed. Both types of LLMW disposal facilities assumed in the WM PEIS were designed to meet all applicable RCRA disposal requirements.
- To conduct the risk analysis, DOE chose either an existing facility location when one was identified or a central location at the site. DOE used actual environmental settings for the analysis at each candidate site.
- No waste acceptance criteria limitations are imposed at disposal sites. That is, it is assumed that disposal sites can accommodate all waste targeted to them. In siting a disposal facility location on a site, a performance assessment analysis will be conducted to select a site location and define waste acceptance criteria.

Indefinite Storage Under the No Action Alternative

- The No Action Alternative continues current management practices. There would be full treatment to meet land disposal restrictions at only three sites and storage at all sites. Although such storage would be for an indefinite period, the analyses for storage used the same 20-year forecast for waste generation and evaluated impacts for the 20-year period in the same way as was done for 10 years of operation for the action alternatives. This was for consistency, to provide a baseline against which all other alternatives could be compared.
- The analyses assumed that all LLMW would be newly packaged. Existing storage was utilized for non-alpha waste when available; however, new storage facilities would be constructed for alpha LLMW and for any waste that exceeded the available storage capacity already on site.
- Risks, other environmental impacts, and costs were calculated for storage facilities using similar assumptions as for treatment and disposal facilities. The evaluation of human health risks includes worker risks from direct radiation and inhalation during operations and physical trauma during construction and operations. Waste containers in storage were assumed not to deteriorate, with very low emissions assumed to be released through the ventilation system from the waste containers. Potential accidents during storage are considered in the discussion of accidents in Section 6.4.

- After the initial packaging and construction of new storage facilities, no repackaging or replacement of storage was considered necessary for the remainder of the 20-year period of analysis. A longer period of storage (30–50 years) could require repackaging and facility replacement due to degradation, with corresponding impacts and costs.
- The results of the analysis of impacts in the following sections of Chapter 6 only consider the impacts for storage over the first 20 years of an indefinite period. Unlike the action alternatives, risks and other impacts that potentially exceed those predicted for the first 20 years could occur in the period beyond 20 years. The option of indefinite storage does not avoid impacts but rather causes impacts to occur every year for an indefinite period of time. A discussion of the longer term impacts for indefinite storage is presented in Section 6.16.

6.2.4 Transportation Analysis and Assumptions

DOE analyzed transportation impacts associated with each LLMW alternative. Both truck and rail transportation were analyzed using computerized routing models following the general principle of minimizing distance and transportation time. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines. However, these are conceptual routes determined for the purpose of risk assessments. They do not necessarily represent the actual routes that would be used to transport waste. Actual routes will be determined during the transportation planning process described in Section 4.3.10.

In general, the risk to populations or individuals from transportation of radioactive materials is directly proportional to the external dose rate, which is a measure of the external radiation (principally gamma radiation) emitted from the shipment. For analytical purposes, DOE assumed that the average dose rate of each shipment would not exceed 1 millirem per hour at 1 meter from the shipping container (consistent with DOE's historical practices), although DOT regulations allow a higher dose rate of 10 millirem per hour at 2 meters from the container (49 CFR 173).

The shipment of the hazardous components of LLMW is regulated by the DOT as a means to protect the public from harm in the event of a potential release. All DOE shipments of LLMW would meet the numerous packaging and containment regulatory standards based on the hazardous components and characteristics of the waste.

Transportation of hazardous and radioactive materials, substances, and wastes is governed by U.S. Department of Transportation, NRC, and EPA regulations, and the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

6.3 Low-Level Mixed Waste Alternatives

DOE analyzed seven alternatives for CH, nonalpha LLMW within the four broad categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. Treatment and disposal activities vary by alternative and by site. The foldout table at the end of this chapter shows the sites at which LLMW would be treated and disposed of under each alternative. This table is designed to be used as a quick reference when reading the LLMW impact sections.

The LLMW analysis considered treatment and disposal separately, first focusing on treatment and then using treatment residues as inputs for the disposal analysis. Each alternative was developed in order to assess environmental impacts, human health risks, and costs associated with the range of LLMW treatment and disposal options, and to provide input for programmatic decisions about where to locate LLMW treatment and disposal facilities.

Remote-handled waste requires special handling facilities for treatment and disposal. Under all alternatives, RH waste is treated and disposed of at the same four sites which house the majority of RH waste: the Hanford Site, INEL, ORR, and SRS.

Alpha LLMW requires special handling and treatment because of the adverse health effects that can occur as a result of inhalation or ingestion of alpha particles. Alpha LLMW exists at 10 sites. Sites where alpha wastes are treated or disposed of are indicated in each of the alternative tables by the alpha symbol (∝).

Tables 6.3–1 to 6.3–7 show, for each alternative, the percentage of waste received from offsite for each treatment or disposal site. The percentages are derived from the waste volumes presented in this chapter and include updated LLMW volumes for these two sites: ANL-E and NTS.

6.3.1 No Action Alternative

The No Action Alternative provides a baseline for the analysis by considering treatment of LLMW at facilities that are currently capable of treating to meet LDRs, and indefinite storage of the waste onsite at all LLMW sites. INEL, ORR, SRS, and other sites to a lesser extent, are capable of some treatment to meet LDRs. Other sites may experience impacts from the construction of expanded storage, onsite shipping, or certification facilities (where the waste would be examined, characterized, and certified for shipment). These storage impacts are included in the WM PEIS in totals listed under treatment for the No Action Alternative. Under this alternative, no new treatment facilities would be built. Figure 6.3–1 and Table 6.3–1 illustrate the No Action Alternative. Because the No Action Alternative involves less treatment than other alternatives and no disposal, it will generally have smaller impacts than the other alternatives for the 20-year period of analysis. Impacts and costs would be expected beyond 20 years, however, and are discussed in Section 6.16. The No Action Alternative would not comply with RCRA because all the waste would not be treated to meet LDRs and would be placed in indefinite storage rather than in disposal facilities.

6.3.2 Decentralized Alternative

The Decentralized Alternative considers treatment of waste to meet RCRA requirements at all 37 LLMW sites. No untreated waste will be shipped offsite to any of the 37 treatment sites. Treated wastes from the smaller sites will be shipped to the larger sites for disposal. For purposes of analysis, DOE examined the impacts from treatment at the 16 major sites. Two of the 16 sites (BNL and SNL-NM) have relatively small amounts of LLMW (less then 200 cubic meters). DOE assumed that the impacts at these sites could be used to estimate the health and environmental impacts at the other 21 sites, most of which likewise have less than 200 cubic meters of LLMW. However, costs were calculated using data from all 37 sites. Figure 6.3–2 and Table 6.3–2 illustrate the Decentralized Alternative.

6.3.3 Regionalized Alternatives

The Regionalized Alternatives consider the consolidation of waste for treatment and disposal. Four LLMW Regionalized Alternatives were analyzed. The Regionalized Alternatives were developed to bound a reasonable range of intermediate variations for treatment and disposal.

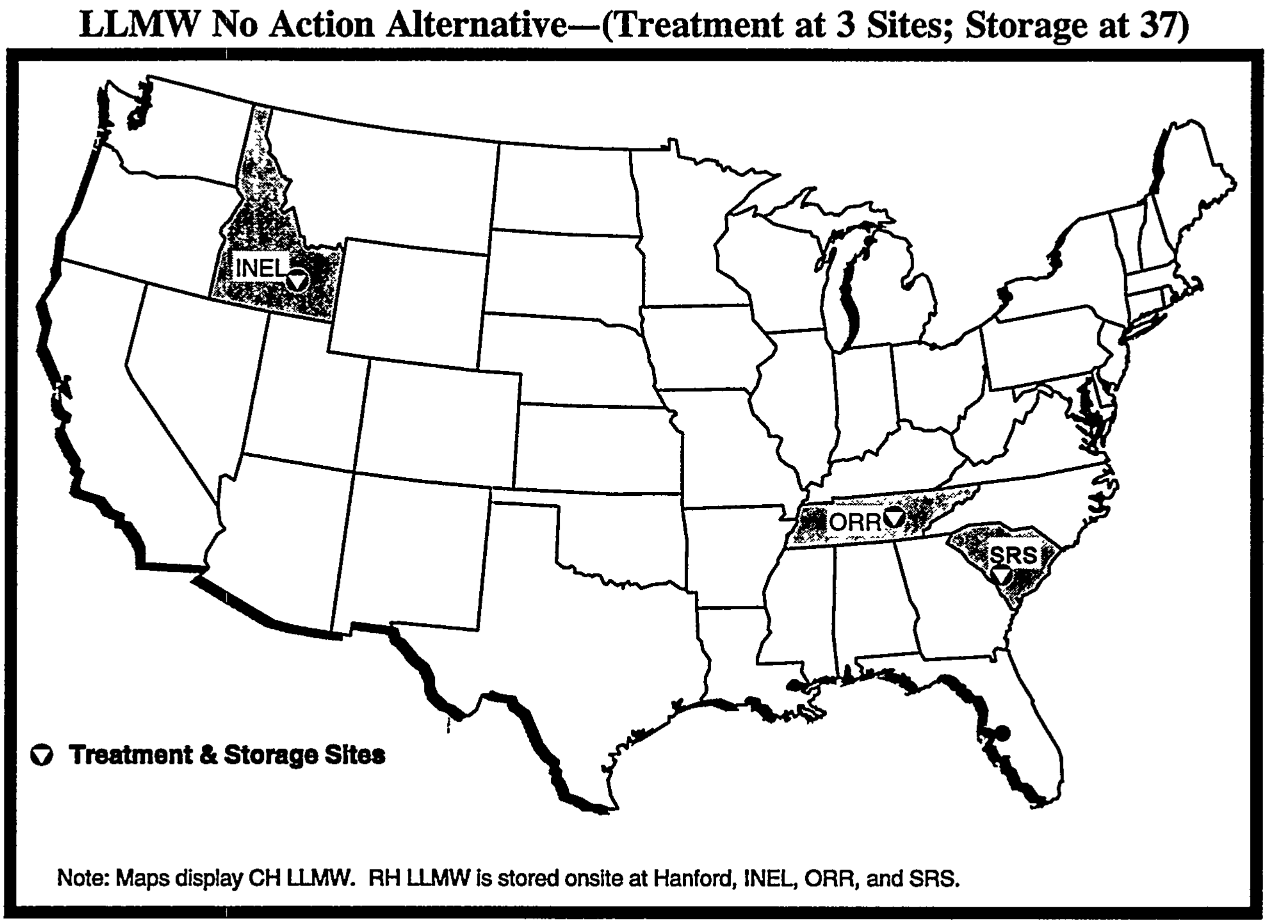


Figure 6.3–1. LLMW No Action Alternative

	Generating Sites			
	INEL	ORR	SRS	ANL-E, Ames, BCL, Bettis, BNL, Charleston, ETEC, FEMP, GA, GJPO, Hanford, KAPL, KCP, LANL, LBL, LEHR, LLNL, Mare Is, Mound, Norfolk, NTS, Pantex, Pearl H, PGDP, Pinellas, Ports Nav, PORTS, PPPL, Puget So, RFETS, RMI, SNL-NM, UofMO, WVDP
Treat (% Rec'd From Offsite)	INEL (0)	ORR (0)	SRS (0)	Onsite wastewater treatment only, as required
Store (% Rec'd From Offsite)	INEL (0)	ORR (0)	SRS (0)	Onsite

Note: Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–1. LLMW No Action Alternative

LLMW Decentralized Alternative—(Treatment at 37 Sites; Disposal at 16)

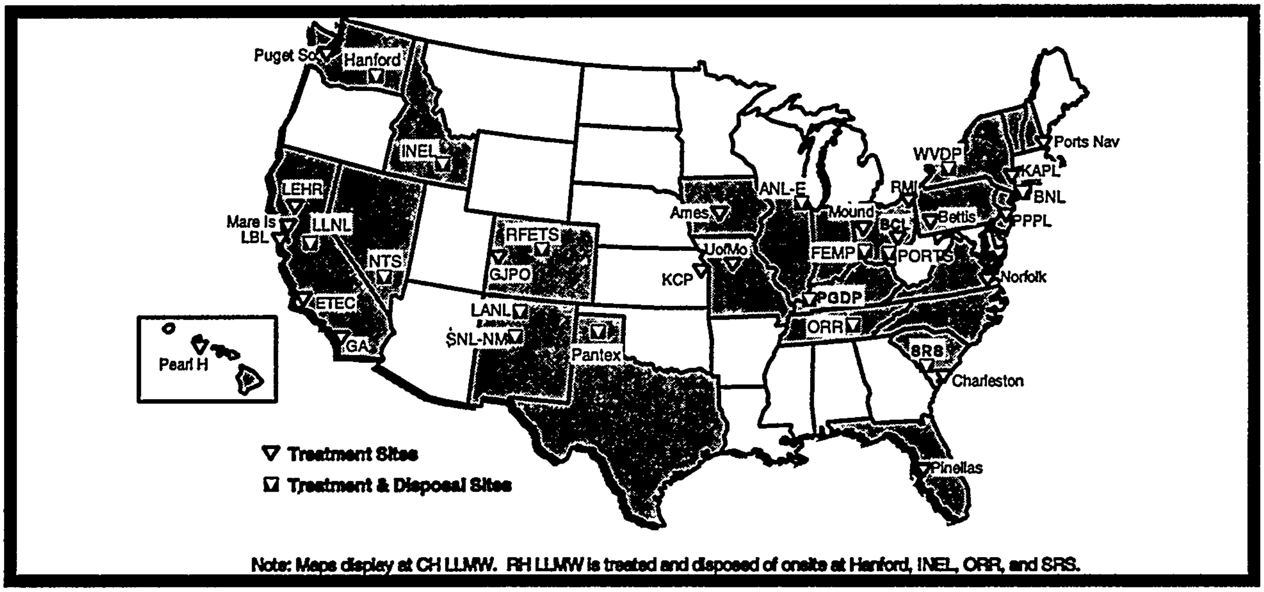


Figure 6.3–2. LLMW Decentralized Alternative

	Generating Sites								
	ANL-E Ames	BCL Bettis KAPL Mound Ports Nav PORTS PPPL RMI	BNL	Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS, SRS∝ UofMO∝ WVDP∝	ETEC GA LBL LEHR LLNL Mare Is	GJPO RFETS RFETS∝	FEMP	Hanford, Pearl H Puget So	INEL INEL∝
Treat (% Rec'd From Offsite)	ONSITE TREATMENT AT GENERATING SITES								
Dispose (% Rec'd From Offsite)	ANL-E (<1)	PORTS (1)	BNL (0)	SRS (1)	LLNL (11)	RFETS (<1)	FEMP (0)	Hanford (<1)	INEL (0)

	Generating Sites							
	SNL-NM	KCP PGDP UofMO	LANL LANL∝ SNL-NM∝	ORR	Pantex	WVDP	NTS	LLNL∝ LBL∝
Treat (% Rec'd From Offsite)	ONSITE TREATMENT AT GENERATING SITES							LLNL
Dispose (% Rec'd From Offsite)	SNL-NM (0)	PGDP (<1)	LANL (0)	ORR (0)	Pantex (0)	WVDP (0)	NTS (1)	

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–2. LLMW Decentralized Alternatives

Regionalized Alternative 1 considers treatment at 11 sites and disposal at 12 (those same 11 sites plus NTS). Regionalized Alternative 2 analyzes the impacts of treatment at seven sites with disposal at six sites. Under this alternative, two of the treatment sites (RFETS and PORTS) are not considered for disposal, but NTS is added for disposal only. Regionalized Alternative 3 analyzes the same seven treatment sites as Regionalized Alternative 2, but considers disposal at only one site, NTS. Regionalized Alternative 4 considers treatment and disposal at four sites—Hanford, INEL, ORR, and SRS, and disposal at six sites (the four treatment sites, plus LANL and NTS). Figures 6.3–3 to 6.3–6 and Tables 6.3–3 to 6.3–6 illustrate the Regionalized Alternatives.

6.3.4 CENTRALIZED ALTERNATIVE

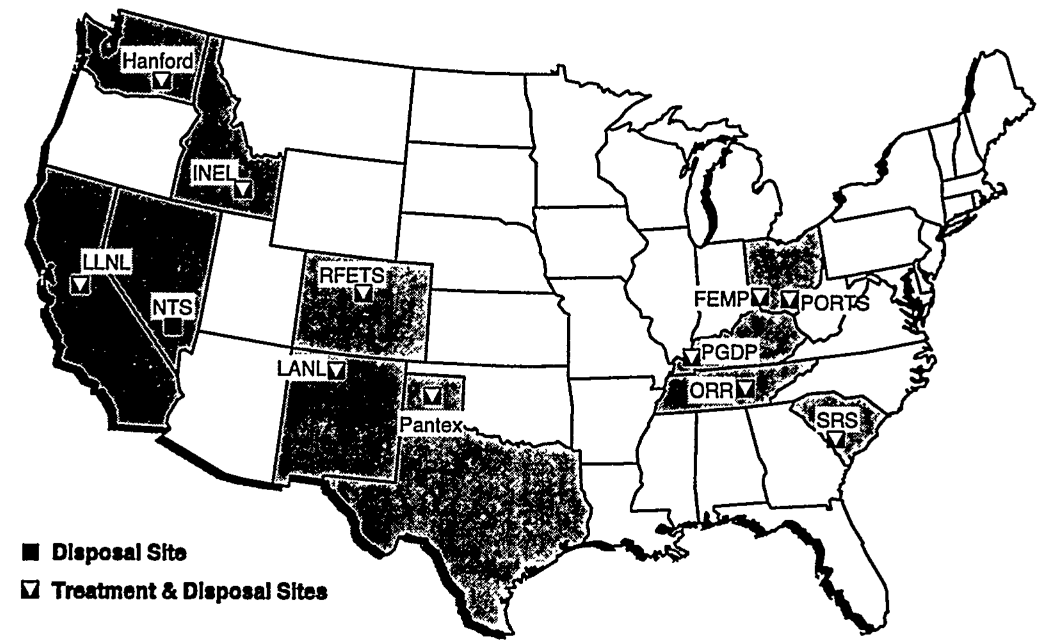
The Centralized Alternative considers LLMW treatment and disposal at a single site within the complex, the Hanford Site. Regionalized Alternative 3 also considers disposal at a single site, NTS, to provide an alternative to Centralized disposal at the Hanford Site. Other sites may experience impacts from the construction of facilities where the waste would be examined, characterized, certified, and prepared for shipment. The other sites in the Centralized Alternative may also experience impacts from the treatment of wastewater that is not shipped offsite. Figure 6.3–7 and Table 6.3–7 illustrate the Centralized Alternative.

6.3.5 RATIONALE FOR SELECTING TREATMENT AND DISPOSAL SITES

How were the treatment sites selected?

The seven LLMW treatment alternatives were developed to cover the range of reasonable alternatives. One to 37 sites are available for treatment (the Centralized and Decentralized Alternatives, respectively). DOE selected four intermediate alternatives treating LLMW at 4 to 11 sites (the Regionalized Alternatives). To select the variations of the Regionalized Alternative, DOE focused on the sites where the largest volumes of LLMW are located and transportation would be minimized. Alpha and RH LLMW would be sent to the closest facility capable of treating those wastes. For all alternatives, DOE assumed that some treatment would be practical at every site. This practical treatment would include initial treatment of aqueous liquids at the site of generation using techniques such as evaporation, neutralization, precipitation, filtration, coagulation, or limited solidification.

LLMW Regionalized Alternative 1—(Treatment at 11 Sites; Disposal at 12)



Note: Maps display CH LLMW. RH LLMW is treated and disposed of onsite at Hanford, INEL, ORR, and SRS.

Figure 6.3–3. LLMW Regionalized Alternative 1

	Generating Sites												
	BCL BNL Bettis KAPL Ports Nav PORTS PPPL RMI WVDP	ANL-E Ames Mound	FEMP	Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS SRS∝ UofMO∝ WVDP∝	ETEC GA LBL LEHR LLNL Mare Is	LBL∝ LLNL∝	GJPO RFETS RFETS∝	Hanford Pearl H Puget So	INEL INEL∝ NTS	KCP PGDP UofMO	LANL LANL∝ SNL-NM SNL-NM∝	ORR	Pantex
Treat (% Rec'd From Offsite)	PORTS (14)	FEMP (9)		SRS (1)	LLNL (1)		RFETS (<1)	Hanford (<1)	INEL (10)	PGDP (<1)	LANL (4)	ORR (0)	Pantex (0)
Dispose (% Rec'd From Offsite)	PORTS (46)		FEMP (0)	SRS (1)	LLNL (11)	NTS (100)	RFETS (<1)	Hanford (<1)	INEL (10)	PGDP (<1)	LANL (2)	ORR (0)	Pantex (0)

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–3. LLMW Regionalized Alternative 1

LLMW Regionalized Alternative 2—(Treatment at 7 Sites; Disposal at 6)

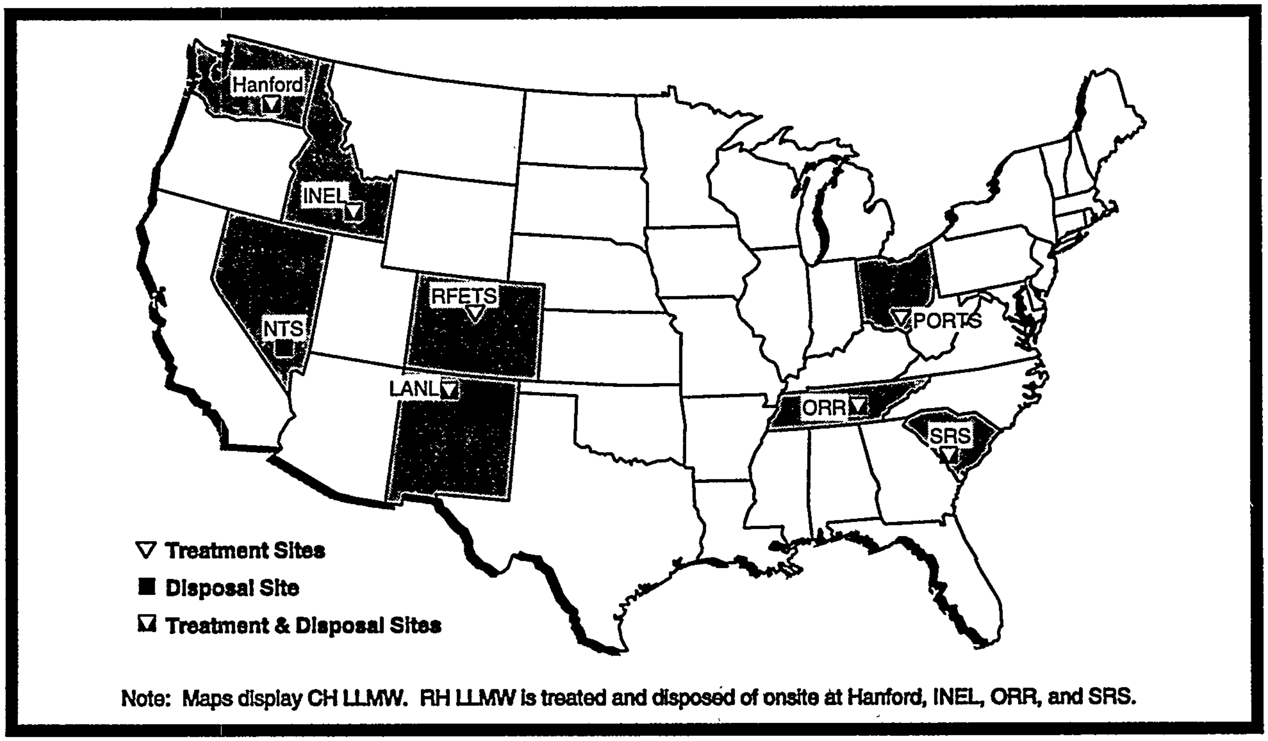


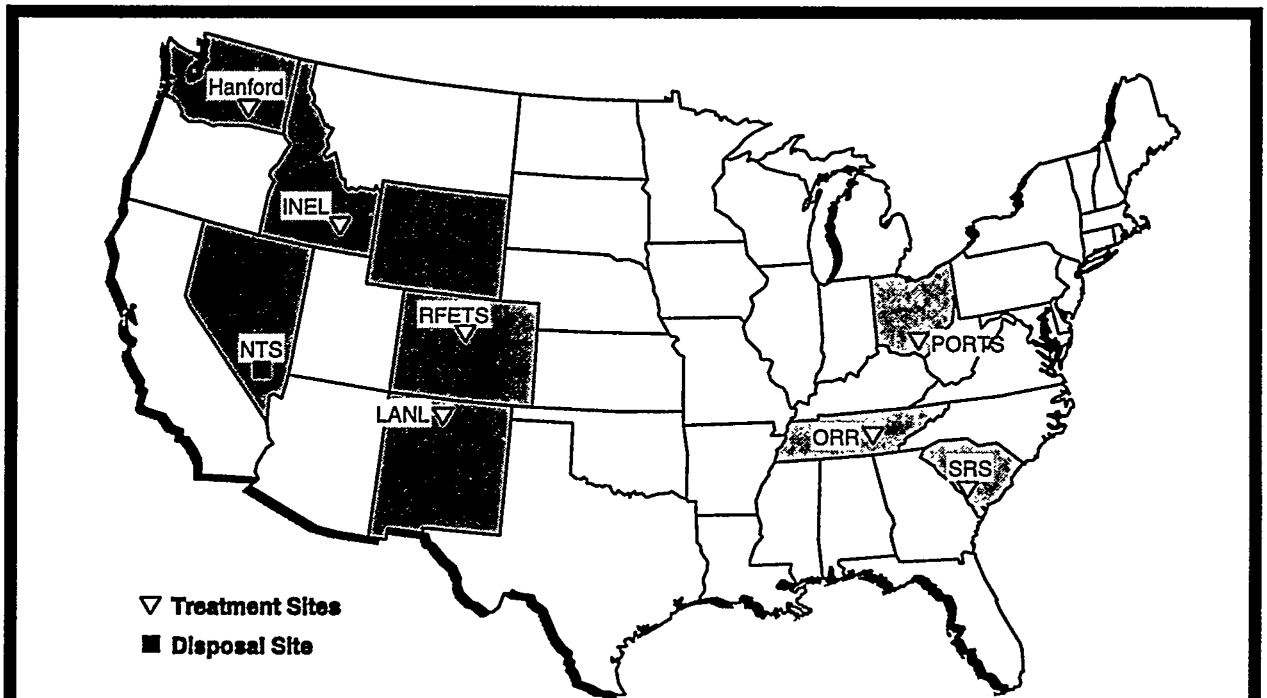
Figure 6.3–4. LLMW Regionalized Alternative 2

	Generating Sites							
	ANL-E Ames BCL BNL Bettis FEMP KAPL Mound Ports Nav PORTS PPPL RMI WVDP	ORR PGDP UofMO	Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS SRS∝ UofMO∝ WVDP∝	ETEC GA INEL INEL∝ LBL∝ LLNL∝ NTS	GJPO KCP RFETS RFETS∝	LANL LANL∝ Pantex SNL-NM SNL-NM∝	Hanford LBL LEHR LLNL Mare Is Pearl H Puget So	
Treat (% Rec'd From Offsite)	PORTS (9)	ORR (1)	SRS (1)	INEL (6)	RFETS (<1)	LANL (22)	Hanford (7)	
Dispose (% Rec'd From Offsite)	ORR (35)		SRS (1)	INEL (9)	LANL (97)		Hanford (7)	NTS[a] (0)

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.
[a] This site disposes residues obtained from onsite wastewater treatment.

Table 6.3–4. LLMW Regionalized Alternative 2

LLMW Regionalized Alternative 3—(Treatment at 7 Sites; Disposal at 1)



Note: Maps display CH LLMW. RH LLMW is treated and disposed of onsite at Hanford, INEL, ORR, and SRS.

Figure 6.3–5. LLMW Regionalized Alternative 3

	Generating Sites						
	ANL-E Ames BCL BNL Bettis FEMP KAPL Mound Ports Nav PORTS PPPL RMI WVDP	Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS SRS∝ UofMO∝ WVDP∝	ORR PGDP UofMO	ETEC GA INEL INEL∝ LBL∝ LLNL∝ NTS	GJPO KCP RFETS RFETS∝	Hanford LBL LEHR LLNL Mare Is Pearl H Puget So	LANL LANL∝ Pantex SNL-NM SNL-NM∝
Treat (% Rec'd From Offsite)	PORTS (9)	SRS (1)	ORR (1)	INEL (6)	RFETS (<1)	Hanford (7)	LANL (22)
Dispose (% Rec'd From Offsite)	NTS (100)						

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–5. LLMW Regionalized Alternative 3

LLMW Regionalized Alternative 4—(Treatment at 4 Sites; Disposal at 6)

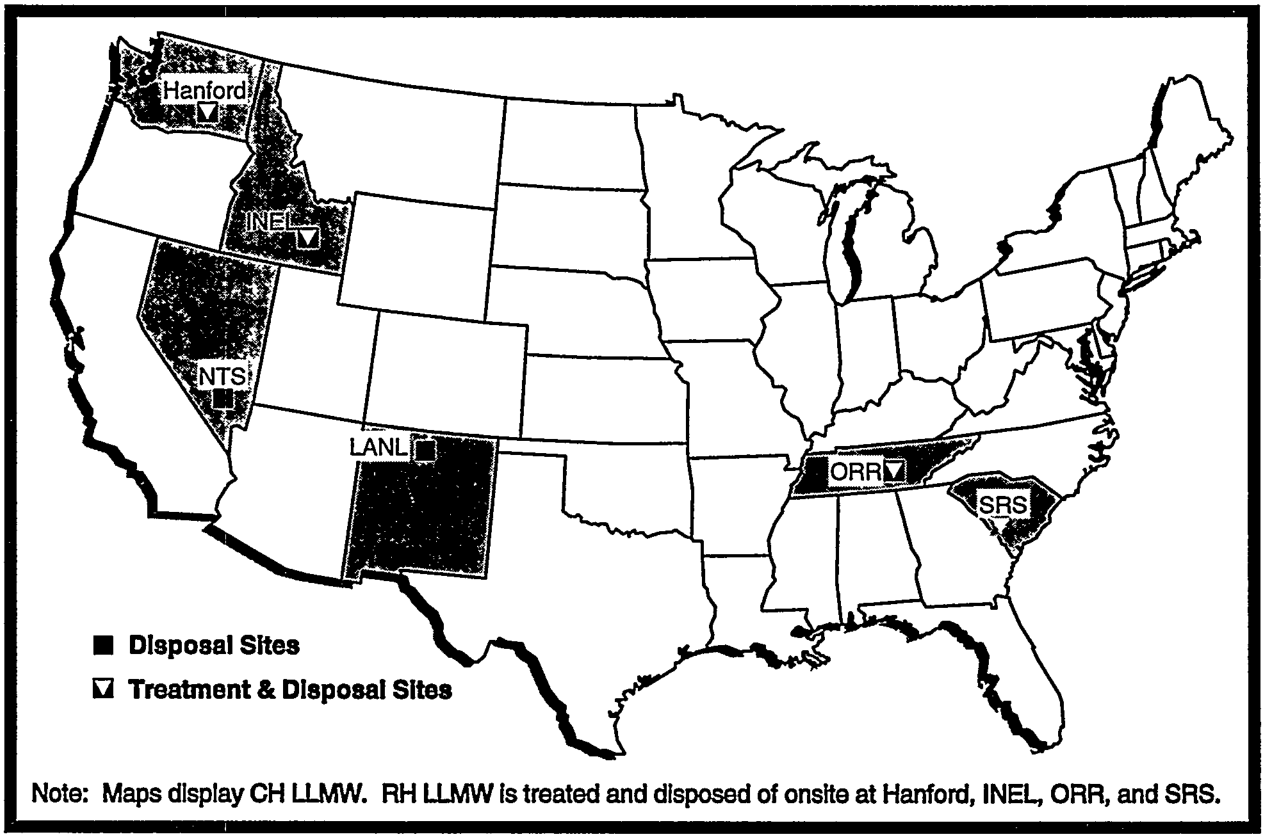


Figure 6.3–6. LLMW Regionalized Alternative 4

	Generating Sites					
		Bettis∝ Charleston Mound∝ Norfolk Pinellas SRS SRS∝ UofMO∝ WVDP∝	ANL-E, Ames, BCL, BNL, Bettis, FEMP, KAPL, KCP, Mound, ORR, PGDP, Ports Nav, PORTS, PPPL, RMI, WVDP, UofMO	ETEC, GA, GJPO, INEL, INEL∝, LANL, LANL∝, LBL∝, LLNL∝, NTS, Pantex, RFETS, RFETS∝, SNL-NM, SNL-NM∝		Hanford, LBL, LEHR, LLNL, Mare Is, Pearl H, Puget So
Treat (% Rec'd From Offsite)		SRS (1)	ORR (38)	INEL (44)		Hanford (7)
Dispose (% Rec'd From Offsite)	NTS[a] (0)	SRS (1)	ORR (38)	INEL (76)	LANL[a] (0)	Hanford (7)

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.
[a] These sites dispose of residues obtained from onsite wastewater treatment.

Table 6.3–6. LLMW Regionalized Alternative 4

LLMW Centralized Alternative—(Treatment and Disposal at 1 Site)

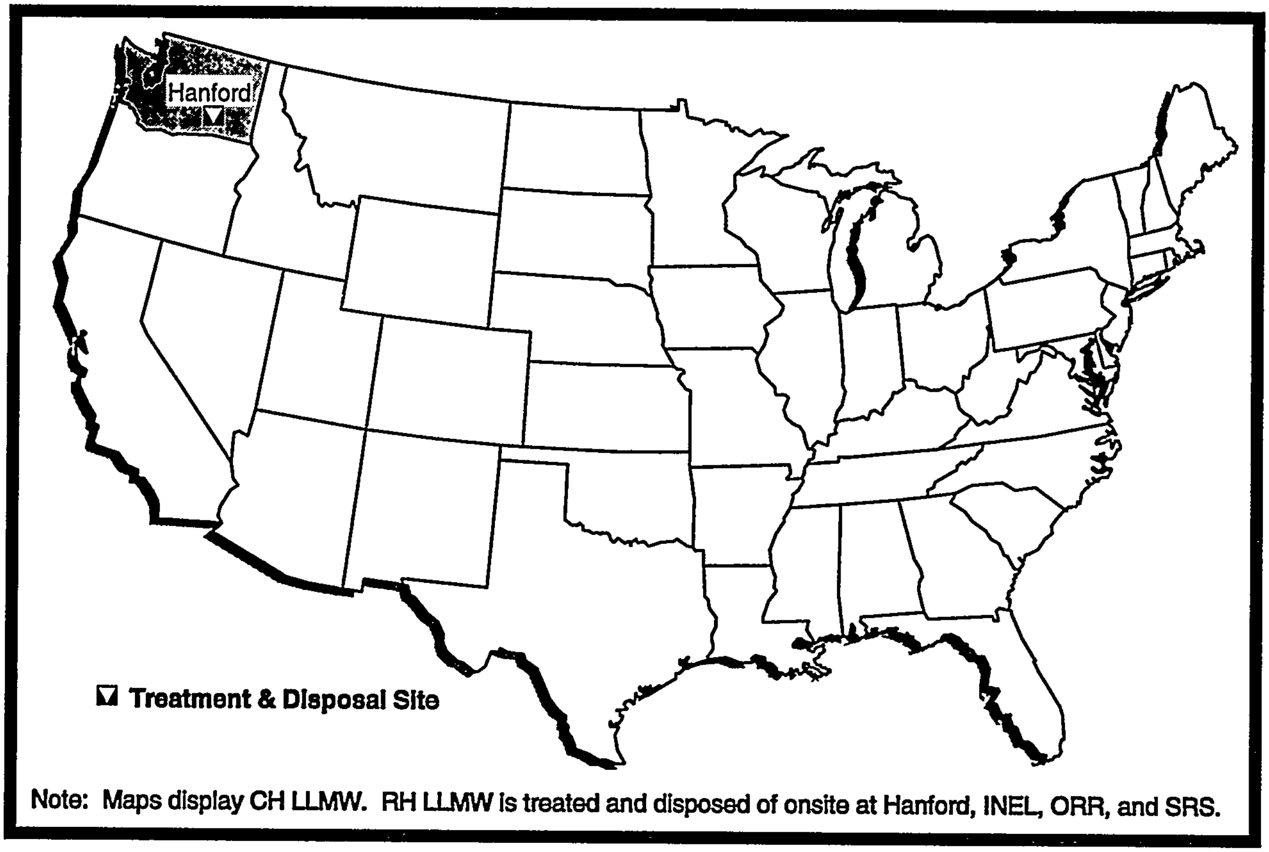


Figure 6.3–7. LLMW Centralized Alternative

	Generating Sites			
	Bettis∝, Charleston, Mound∝, Norfolk, Pinellas, SRS, SRS∝, UofMO∝, WVDP∝	ANL-E, Ames, BCL, BNL, Bettis, FEMP, KAPL, KCP, Mound, ORR, PGDP, Ports Nav, PORTS, PPPL, RMI, WVDP, UofMO	ETEC, GA, GJPO, INEL, LANL, LANL∝, LBL∝, LLNL∝, NTS, Pantex, RFETS, RFETS∝ SNL-NM, SNL-NM∝	Hanford, LBL, LEHR, LLNL, Mare Is, Pearl H, Puget So
Treat (% Rec'd From Offsite)	Hanford (83)			
Dispose (% Rec'd From Offsite)	Hanford (86)			

Notes: ∝ = contact-handled alpha LLMW. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 6.3–7. LLMW Centralized Alternative

The Regionalized Alternatives consider the impacts of treatment to meet LDRs at selected waste consolidation sites. Regionalized Alternative 1 considers treatment at 11 sites. This alternative was developed by identifying the location of most of the DOE LLMW and looking for logical site groupings. Nine sites have 20-year projected levels of LLMW that exceed 1,000 cubic meters. The next largest site contains approximately half as much waste, and the other small sites follow with decreasing amounts.

In Regionalized Alternatives 2 and 3, seven sites are considered potential treatment locations. DOE chose the six sites with the highest waste volumes, and added LANL because it has a larger volume of transuranic waste (TRUW) that eventually may be reclassified as alpha LLMW due to its radionuclide content. Regionalized Alternative 4 consists of the sites with the three highest volumes (Hanford, INEL, and ORR), as well as SRS, which has the sixth largest volume. SRS was chosen because of its high volumes of alpha LLMW and TRUW, some of which eventually may be reclassified as LLMW. In addition, SRS has under construction an incinerator with an annual LLMW treatment capacity of 8,200 cubic meters.

In the Centralized Alternative, all LLMW would be shipped to the Hanford Site for treatment. The Hanford Site currently has the second largest volume of LLMW. However, as Hanford's HLW is treated, a substantial portion of that waste will be separated and thereafter managed as LLMW, thereby making the Hanford Site the largest LLMW site.

How were disposal sites selected?

Candidate disposal sites were selected to reflect a reasonable range of alternatives. However, unlike the treatment analysis, the disposal analysis did not evaluate every site for disposal. Instead, 16 candidate sites were selected as the reasonable upper bound based on screening performed by DOE for consistency with the FFCAct.

To narrow the number of possible LLMW disposal sites, DOE applied three exclusionary criteria to the 37 sites with LLMW: (1) sites could not be within a designated 100-year floodplain, (2) sites could not be within 200 feet of a seismic fault, and (3) sites were required to have sufficient area for a 100-meter buffer zone between the disposal structure and the site boundary.

Using the three criteria, DOE reduced the number of reasonable sites to 22 locations. Three additional sites (General Atomics, Pinellas Plant, and ETEC) were removed with the concurrence of the States for technical and practical considerations, leaving 19 sites for disposal consideration.

DOE eliminated three other sites based on the following rationales: (1) KAPL is a Navy site and thus was not considered as a DOE disposal site, (2) Mound was not considered because it is relatively small and some of its land is being returned to the State, and (3) Bettis was not considered because of sloping terrain and unstable geologic conditions and because it is a Navy site.

The Decentralized Alternative looked at disposal at the remaining 16 sites and the Centralized Alternative looked at disposal at one site—the Hanford Site. The Hanford Site was analyzed because it is expected to have the largest volume of LLMW. In addition, NTS was analyzed as the only disposal site under Regionalized Alternative 3.

DOE selected two intermediate alternatives, disposing at 12 and 6 sites (under the Regionalized Alternatives). To select these Regionalized Alternatives, DOE focused on the 11 sites with the largest volume of LLMW and added NTS because it has a LLMW disposal facility that has a pending permit application. The next logical consolidation point for LLMW disposal was a 6-site alternative, to be consistent with the six currently operating LLW disposal facilities—the Hanford Site, INEL, LANL, NTS, ORR, and SRS. NTS was considered in Regionalized Alternative 3 to provide a comparison and an alternative to the single disposal location selected under the Centralized Alternative. The Centralized Alternative coupled the selection of a treatment and disposal site at the Hanford Site because of the anticipated onsite large volumes of LLMW.

6.4 Health Risks

The number of worker fatalities is about three times higher than for other receptor groups, driven by physical injury hazards. As the number of sites decrease, facilities become larger and programwide physical injuries decrease, reflecting an economy of scale and fewer workers. The most important influence on offsite population risk is LLNL treatment of tritium in the Decentralized and Regionalized 1 Alternatives. There are no other notable trends for offsite population risks. For disposal, concentrations of radionuclides and chemicals in the groundwater near disposal facilities are estimated to exceed applicable standards at several sites, demonstrating the need for performance-based waste acceptance criteria. More extensive pretreatment of chemicals than assumed for the WM PEIS analysis and careful management of radionuclide concentrations and waste forms would be required to assure acceptable water quality and human health risks. Transportation risks are low in all alternatives, reflecting low vehicle miles.

Health risk impacts can result from exposure to radiation and chemicals and from physical trauma associated with constructing and operating treatment and disposal facilities or transporting waste. Health effects resulting from radiation and chemical exposure, whether from sources external or internal to the body, can affect either the exposed individual (known as "somatic" effects) or descendants of the exposed individual (known as "genetic" effects). This section discusses the estimated adverse health impacts resulting from radiation and chemical exposures as well as from physical hazards for each LLMW treatment and disposal alternative. Details of the LLMW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5, Appendix D, and in ORNL technical reports (ORNL, 1995a-c).

Potential health risks to a number of receptor populations and individuals are presented including:

- The offsite population—those individuals living within a 50-mile radius of the site, as well as along transportation routes
- Noninvolved worker population—the workers on DOE sites who are not involved directly in waste management activities
- Waste management worker population (or "waste management workers")—onsite employees in a site's waste management facilities, including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste
- Maximally exposed individual (MEI) for the offsite population—hypothetical individual in the offsite population who would receive the highest total lifetime multimedia dose
- MEI for the noninvolved worker population—hypothetical individual in the noninvolved worker population who would receive the highest total lifetime multimedia dose
- Farm family most exposed lifetime MEI—hypothetical individual in the most exposed lifetime of the farm family who would receive the highest dose from disposal of LLMW
- Hypothetical intruder—an individual who would experience maximum potential future risks from disposal of LLMW upon the loss of institutional control
- Most exposed waste management worker—an individual who would experience potential

The following sections present the impacts for the LLMW alternatives:

6.4 Health Risks
6.5 Air Quality Impacts
6.6 Water Resources Impacts
6.7 Ecological Resources Impacts
6.8 Economic Impacts
6.9 Population Impacts
6.10 Environmental Justice Concerns
6.11 Land Use Impacts
6.12 Infrastructure Impacts
6.13 Cultural Resources Impacts
6.14 Costs
6.15 Environmental Restoration Analysis
6.16 Comparison of Alternatives Summary

noncancer effects, as estimated using the Exposure Index, following exposure to the hazardous chemical constituents of LLMW

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer fatalities from radiation exposure
- Cancer incidences from radiation or chemical exposure
- Genetic effects from radiation exposure
- Noncancer effects from chemical exposure (e.g., headaches, nasal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and developmental toxicity)

Maximally Exposed Individual

In keeping with standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week, for the 10-year period of treatment operations analyzed in the WM PEIS.

Interpreting the results of health risk analyses involves consideration of both uncertainties and appropriate standards. See Section 5.4.1 and Appendix D for further discussion of these issues.

Understanding Scientific Notation

Scientific notation is used in this WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10	***Negative Powers of 10***
$10^{1} = 10 \times 1 = 10$	$10^{-1} = 1/10 = 0.1$
$10^{2} = 10 \times 10 = 100$	$10^{-2} = 1/100 = 0.01$
and so on; therefore,	*and so on; therefore,*
$10^{6} = 1{,}000{,}000$ *(or 1 million), etc.*	$10^{-6} = 0.000001$ *(or 1 in 1 million), etc.*

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^{5} *can also be written as 3E+05, and* 3×10^{-5} *is equivalent to 3E-05. Therefore, 3E+05 = 300,000 and 3E-05 = 0.00003.*

The health risk data tables in this section use "E" notation with negative exponents.

Probability is expressed as a number between 0 and 1. The notation 3E-06 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., fatal cancer) will occur in the period covered by the analysis.

6.4.1 Routine Operation Impacts

6.4.1.1 Treatment

For operations involving LLMW treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in LLMW treatment ("noninvolved workers"), and waste management workers directly involved in treatment activities. Impacts were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts. Note that risks from the storage of LLMW are included in the treatment risks for the No Action Alternative, as described in Section 6.3.1.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented.

The sizes of the offsite populations and waste management treatment worker populations used in the health risk analyses are presented in Table 6.4–1. The waste management treatment worker numbers are derived from generic baselines which established the number of personnel required to operate treatment facilities needed to manage a given amount of source term (defined by the respective alternative).

Individual impacts focus on the *probability* that the "maximally exposed individual" (MEI) within each receptor population would experience an adverse health impact. Because the focus is on the MEI, the risk is presented as a probability (e.g., one in one million or 1E–06) of that individual experiencing an adverse health impact, rather than the total number of impacts for a selected population.

DOE analyzed effects of exposure to both radionuclides and chemicals on the receptor groups. The pathways of exposure analyzed were inhalation, ingestion of plants and animals, direct gamma radiation, and absorption of tritium through the skin.

Worker risks associated with physical hazards were evaluated for 20 years: a 10-year period of construction of treatment and disposal facilities, and a subsequent 10-year period of operation. However, worker and public risks from exposure to radionuclides or chemicals (received during the 10-year operation period) were evaluated for an entire lifetime (70 years), because health impacts from airborne contaminants or direct radiation could occur throughout the lifetime of the exposed individual. Table 6.4–2 provides an

Table 6.4–1. Offsite Populations and Waste Management Treatment Worker Populations

Site	Offsite Population*	WM Treatment Worker Population by Alternative[a]						
		NA	D	R-1	R-2	R-3	R-4	C
ANL-E	7,939,785	22	50	23	23	23	23	23
BNL	5,738,554	24	62	16	16	16	16	16
FEMP	2,764,589	165	533	1,233	269	269	269	269
Hanford	377,645	506	2,196	2,065	2,132	2,132	2,268	6,706
INEL	153,061	782	1,588	1,587	2,010	2,010	3,281	278
LANL	159,152	136	590	597	679	679	146	146
LLNL	6,324,234	220	831	915	136	136	136	136
NTS	14,266	330	785	305	305	305	305	305
ORR	881,652	2,434	2,530	2,162	2,177	2,177	3,116	490
PGDP	500,502	55	144	144	48	48	48	48
Pantex	265,185	46	145	145	48	48	48	48
PORTS	639,602	435	1,853	1,353	1,951	1,951	405	405
RFETS	2,171,877	2,407	2,305	2,307	3,506	3,506	1,972	1,972
SNL-NM	610,714	8	20	5	5	5	5	5
SRS	620,618	1,005	1,289	1,290	1,290	1,290	1,291	207
WVDP	1,698,391	9	11	10	10	10	11	11

Notes: NA = No Action, D = Decentralized; R1–R4 = Regionalized; C = Centralized; * = within 50-mile radius of sites.
[a] Waste Management worker population estimates represent full-time equivalents (FTEs) over the entire construction and operation period.

overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for LLMW treatment.

6.4.1.2 Disposal

Health risks resulting from disposal were evaluated for waste management workers handling the treated LLMW, for an onsite "hypothetical farm family" located 300 meters from the center of the disposal facility, and for a hypothetical "intruder" into the disposal facility after the facility has been closed.

Table 6.4–2. LLMW Treatment Health Risk Analysis Components

LLMW Treatment[a]					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of trauma fatalities	WM workers	Physical hazards	Physical hazards	20 years	6.4–4
Number of cancer fatalities	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–4
	Noninvolved workers		Inhalation, direct radiation		
	WM workers		Inhalation, direct radiation		
Number of cancer incidences	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–5
		Chemicals	Inhalation, ingestion		
	Noninvolved workers	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
	WM workers	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
Number of genetic effects	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–5
	Noninvolved workers		Inhalation, direct radiation		
	WM workers		Inhalation, direct radiation		
Probability of cancer fatality	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–7 6.4–8
	Noninvolved worker MEI		Inhalation, direct radiation		
Probability of cancer incidence	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–9
		Chemicals	Inhalation, ingestion		
	Noninvolved worker MEI	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
Probability of genetic effects	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	6.4–9
	Noninvolved worker MEI		Inhalation, direct radiation		
Noncancer risk	Offsite MEI	Chemicals	Inhalation, ingestion	10 years	6.4–10
	Noninvolved worker MEI		Inhalation		
	WM worker		Inhalation		

[a] Treatment risks under the No Action Alternative include risks from storage of LLMW.

The waste management workers were assumed to be exposed through direct radiation during disposal operations. Risks to the WM workers were estimated for one lifetime.

> ***Hypothetical Farm Family and Intruder***
>
> *The "hypothetical farm family" is an imaginary family assumed to live 300 meters downgradient of the center of a waste disposal unit. The family engages in farming activities such as growing and consuming their own crops and livestock, and uses groundwater for drinking water and for watering the crops and animals. This is an estimated maximum exposure scenario taking place in the future at a time when institutional controls no longer exist. The scenario is analyzed to determine potential upper-bound exposures by ingestion of contaminated groundwater.*
>
> *The hypothetical "intruder" is an imaginary adult who drills a well directly through a LLMW disposal unit to the groundwater. As a result of the drilling, soil contaminated with radionuclides and hazardous chemicals from within the unit is brought to the surface, where it mixes with the top layers of the surface soil. The individual farms the land and eats the crops. The intruder scenario occurs after the failure of institutional control. This scenario is consistent with the analysis required for disposal facilities under DOE Order 5820.2A (DOE, 1988).*

For the farm family and intruder analyses, DOE assumed that waste was disposed of in either aboveground or belowground disposal units, depending on the site, each with a capacity of 18,000 and 12,000 cubic meters, respectively. Additional units were added as needed to dispose all of the waste on a site. Each disposal unit was assumed to affect a separate farm family and a separate intruder. Thus, the effects on the farm family (and on the intruder) were assumed to come from a single disposal unit, rather than from a combination of all the units at a site.

The exposure pathways for the hypothetical farm family were ingestion of groundwater and ingestion of plants and animals contaminated by irrigation water. The groundwater was assumed to be contaminated by a breach in each disposal unit immediately after shallow land burial, 300 years after disposal in aboveground vaults, or 750 years after disposal in belowground vaults. The contaminants were assumed to leach over time from their solidified waste form to create a plume of contamination. Individual contaminated plumes were then assumed to migrate to the receptor wells without mixing with each other. The risks to the hypothetical farm family were estimated over a 10,000-year period because the maximum exposure would occur in the future when the peak of contaminant concentration passes the well. Results of the farm family analyses are presented as the probability of cancer fatality or cancer incidence for an individual during the 70-year lifetime that presents the greatest exposure of the 143 lifetimes (i.e., 10,000 years) analyzed. The 10,000 year period was selected for the analysis to maintain consistency with the "Guidelines for Radiological Performance Assessment of DOE Low-Level Radioactive Waste Disposal Sites" that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessments has since been changed; current guidance suggests that a 1,000-year time period should be used in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A.

The exposure pathways for the hypothetical intruder were inhalation of resuspended contaminated soil, inadvertent ingestion of contaminated soil, ingestion of plants grown in contaminated soil, and direct radiation from contaminated soil. A hypothetical intruder who drills into the disposal facility was assumed to be exposed to contaminated wastes, including radionuclides and hazardous chemicals, that remain at the site. Two hypothetical intrusions were assumed to occur: 100 years and 300 years after closure of the disposal facility. The risks to the hypothetical intruder were estimated for one lifetime (70 years).

Table 6.4–3 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for LLMW disposal.

The health risk impacts associated with the routine operation of LLMW treatment and disposal facilities are presented in Tables 6.4–4 through 6.4–16 of this section. The tables show the estimates of human health risk for both treatment and disposal of LLMW. Summary tables show programwide results by alternative. The site tables in Volume II present the health risk impacts for the 16 major LLMW sites.

This human health risk analysis includes evaluation of both the potential numbers of fatal cancers as well as the numbers of total cancer incidences induced by exposure to radionuclides and direct radiation. The numbers of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases. Note that both the *total cancer incidence* and the *nonfatal cancer incidence* values are overestimated by a factor of about two because the estimates contain a relatively large component of skin cancers. The internal exposure pathways evaluated in this WM PEIS (e.g., inhalation or ingestion of radionuclides) are not likely to induce large numbers of skin cancer cases. However, the International Commission on Radiological Protection (ICRP) dose conversion factor used in this PEIS to estimate total cancer incidence values includes incidences of skin cancer (ICRP, 1990).

6.4.1.3 Estimated Number of Fatalities

Programwide Treatment and Disposal. Table 6.4–4 presents an overview, by alternative, of the total estimated programwide fatalities associated with both treatment and disposal of LLMW. This table presents

Table 6.4–3. LLMW Disposal Health Risk Analysis Components

LLMW Disposal					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of trauma fatalities	WM workers	Physical hazards	Physical hazards	20 years	6.4–4
Number of cancer fatalities	WM workers	Radionuclides	Direct radiation	10 years	6.4–4
Number of cancer incidences	WM workers	Radionuclides	Direct radiation	10 years	6.4–6
Number of genetic effects	WM workers	Radionuclides	Direct radiation	10 years	6.4–6
Probability of cancer fatality	Hypothetical farm family most exposed lifetime MEI	Radionuclides	Ingestion	70 years	6.4–11
	Hypothetical intruder		Inhalation, ingestion, direct radiation		6.4–15 6.4–16
Probability of cancer incidence	Hypothetical farm family most exposed lifetime MEI	Chemicals	Ingestion	70 years	6.4–12
	Hypothetical intruder	Radionuclides	Inhalation, ingestion, direct radiation		6.4–15
		Chemicals	Inhalation, ingestion		
Probability of genetic effects	Hypothetical intruder	Radionuclides	Inhalation, ingestion, direct radiation	70 years	6.4–15
Noncancer risk	Hypothetical intruder	Chemicals	Inhalation, ingestion	70 years	6.4–15

Table 6.4-4. LLMW Treatment and Disposal—Estimated Number of Fatalities Programwide

Alternative	Number of Sites		Treatment				Disposal	
			WM Workers		Number of Offsite Population Radiation Cancer Fatalities	Number of Noninvolved Worker Radiation Cancer Fatalities	WM Workers	
	T	D	Number of Radiation Cancer Fatalities	Number of Physical Hazard Fatalities			Number of Radiation Cancer Fatalities	Number of Physical Hazard Fatalities
No Action[a]	3	--	1	2	*	*	--	--
Decentralized	37	16	1	4	*	*	1	*
Regionalized 1	11	12	1	4	*	*	1	*
Regionalized 2	7	6	1	3	*	*	1	*
Regionalized 3	7	1	1	3	*	*	*	*
Regionalized 4	4	6	1	3	*	*	1	*
Centralized	1	1	1	3	*	*	*	*

Notes: T = treatment; D = disposal; -- = action not applicable for the alternative;* = greater than 0 but less than 0.5.

[a] Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

the estimated number of latent cancer fatalities to the offsite population, noninvolved workers, waste management workers, and hypothetical farm family caused by radiological exposure. In addition, the table shows the estimated number of waste management worker deaths resulting from physical hazards during facility construction and operation.

None of the treatment alternatives results in a fatal cancer to the offsite or noninvolved worker populations. For each alternative, there is at least one estimated fatality associated with treatment operations. Most of these fatalities occur within the waste management worker population, and result from physical hazards involved in construction and operation of LLMW treatment facilities. Waste management workers are the only receptor group exposed to these physical hazards, and therefore, have more estimated fatalities than other receptor groups.

Disposal operations show one estimated fatal cancer for waste management workers in all alternatives, except where disposal is consolidated at one site.

For all alternatives, for both treatment and disposal, the estimated number of fatalities in the waste management worker population due to physical hazards exceeds estimated radiologically induced cancer fatalities in the offsite population and noninvolved workers. In general, fatality risk to waste management workers appears to decrease with increased centralization of activities. Fewer fatalities from physical hazards occur because fewer facilities and worker hours are required when waste management activities are consolidated at one or a few sites.

Site-Level. For all treatment and disposal alternatives, one or more fatalities are estimated only at the Hanford Site in the Centralized Alternative within the waste management worker population as a result of physical hazards. Site-level results for all alternatives are presented in Appendix D and Volume II.

6.4.1.4 Estimated Number of Cancer Incidences and Genetic Effects

Programwide Treatment. Table 6.4–5 presents an overview, by alternative, of the total estimated programwide cancer incidences and genetic effects associated with treatment of LLMW. These impacts result from chemical and radiation exposures of the offsite population, noninvolved workers, and waste management workers. In addition, the table includes radiation dose estimates for each receptor group.

The offsite population and waste management workers are the only receptor groups with estimated cancer incidences greater than or equal to one. The estimated number of cancer incidences from radiation exposure generally exceeds those from chemical exposure for the offsite population and waste management workers.

For waste management workers, impacts are similar across the alternatives, with two cancer incidences in each case except for the No Action Alternative, which has three cancer incidences. For the offsite population, three alternatives (No Action, Decentralized, and Regionalized 1) result in at least one cancer incidence. As the table indicates, consolidating treatment lowers the number of cancer incidences in the offsite population. This is because fewer treatment sites result in potential offsite exposure to fewer people.

Site-Level Treatment. Only one site (the Hanford Site) is estimated to exceed one cancer incidence as a result of treatment activities. The exceedance occurs in the Centralized Alternative within the waste management worker receptor group from radiation exposure. Genetic effects incidence is not estimated to

Table 6.4-5. LLMW Treatment—Estimated Number of Cancer Incidences and Genetic Effects Programwide

Alternative	Number of Sites		Offsite Population				Noninvolved Workers				WM Workers			
			Radionuclide			Chemical	Radionuclide			Chemical	Radiation			Chemical
	T	D	Dose (person-rem)	Number of Cancer Incidences	Number of Genetic Effects	Number of Cancer Incidences	Dose (person-rem)	Number of Cancer Incidences	Number of Genetic Effects	Number of Cancer Incidences	Dose (person-rem)	Number of Cancer Incidences	Number of Genetic Effects	Number of Cancer Incidences
No Action[a]	3	--	570	1	*	*	25	*	*	*	2,100	3	*	*
Decentralized	37	16	340	1	*	*	5	*	*	*	1,300	2	*	*
Regionalized 1	11	12	330	1	*	*	5	*	*	*	1,400	2	*	*
Regionalized 2	7	6	40	*	*	*	1	*	*	*	1,400	2	*	*
Regionalized 3	7	1	40	*	*	*	1	*	*	*	1,400	2	*	*
Regionalized 4	4	6	30	*	*	*	1	*	*	*	1,600	2	*	*
Centralized	1	1	50	*	*	*	1	*	*	*	1,600	2	*	*

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.5.
[a]Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

exceed one for any site under any alternative. Site-level results for all alternatives are presented in Appendix D and Volume II.

Programwide Disposal. Table 6.4–6 presents an overview, by alternative, of the total estimated programwide cancer incidences and genetic effects associated with disposal of LLMW. These impacts result from exposure of waste management workers to direct radiation. Radiation dose estimates are also included in the table.

Each of the alternatives results in cancer incidences within the waste management worker receptor group. The alternatives involving only one disposal site (Regionalized 3 and Centralized) result in one cancer incidence each; all other alternatives each result in two. Thus, waste consolidation at one disposal site decreases the estimated number of cancers for waste management workers.

As shown in Table 6.4–6, less than one incidence of genetic effects resulting from radiation exposure is estimated to occur among the population of waste management workers under each alternative.

Table 6.4–6. LLMW Disposal—Estimated Number of Cancer Incidences and Genetic Effects Programwide

	Number of Sites		WM Workers		
Alternative	**T**	**D**	**Radiation Dose (person-rem)**	**Number of Radiation Cancer Incidences**	**Number of Radiation Genetic Effects**
No Action	3	--	--	--	--
Decentralized	37	16	1,400	2	*
Regionalized 1	11	12	1,400	2	*
Regionalized 2	7	6	1,300	2	*
Regionalized 3	7	1	1,000	1	*
Regionalized 4	4	6	1,600	2	*
Centralized	1	1	900	1	*

Notes: T = treatment; D = disposal; -- = action not applicable for the alternative; * = greater than 0 but less than 0.5.

Site-Level Disposal. Three sites (the Hanford Site, INEL, NTS) pose a risk of cancer incidence greater than one to waste management workers as a result of direct radiation exposure. NTS poses risk greater than one to waste management workers under Regionalized Alternative 3, INEL under Regionalized Alternative 4, and the Hanford Site under the Centralized Alternative.

6.4.1.5 Probability of MEI Cancer Fatalities

Table 6.4–7 summarizes, by alternative, the highest estimated *probability* at any site of fatal cancer from exposure to radiation associated with each LLMW alternative. This table presents the probability of cancer fatality to the MEI within the offsite and noninvolved worker populations. The numbers in this table are the estimated *probabilities* that the MEI will die of latent cancer from radiation exposure. The probability of a cancer fatality for the MEI was calculated at each site, and the highest value at a single site under each alternative is presented in Table 6.4–7. The MEI risk is not a combined total of risks across all of the sites.

Three treatment alternatives (No Action, Decentralized, and Regionalized 1) have estimated probabilities of fatal cancer for the offsite MEI that are approximately one order of magnitude higher than the values for the other alternatives.

Table 6.4–7. LLMW Treatment—Greatest Probability of Cancer Fatality at Any LLMW Site

Alternative	Number of Sites		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
	T	D		
No Action	3	NA	3E–06	9E–06
Decentralized	37	16	3E–06	7E–07
Regionalized 1	11	12	3E–06	7E–07
Regionalized 2	7	6	3E–07	3E–07
Regionalized 3	7	1	3E–07	3E–07
Regionalized 4	4	6	3E–07	3E–07
Centralized	1	1	5E–07	6E–07

Notes: T = treatment; D = disposal; NA = not applicable. Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

Table 6.4–8 presents the probability of a fatal cancer from radiological exposure for the offsite MEI for all sites by treatment alternative. The data in Table 6.4–8 are graphically presented in Figure 6.4–1. LLNL, under the Decentralized and Regionalized 1 Alternatives, is the site with the highest estimated cancer fatality probability. This risk is due to exposure to tritium that would be released during treatment operations if LLNL were used as a treatment site. It should be noted that the estimated releases of radionuclides that produce the cancer fatality probability estimates presented in Table 6.4–8 are based on the conceptual thermal treatment of LLMW. Emissions of particulate radionuclides from thermal treatment generally are limited by the use of effective engineering controls (e.g., HEPA filtration). However, tritium in the waste forms water vapor upon thermal treatment and readily escapes in the airborne emissions from the process. The largest estimated releases of radionuclides from the treatment of LLMW result from the thermal treatment of waste containing tritium. These estimated releases, and the resulting potential health risks, illustrate the need to carefully analyze and document risks associated with the use of thermal treatment of substantial quantities of tritium. DOE is exploring alternative technologies for treating LLMW for use when potential health risks from thermal treatment are determined to be unacceptable.

The release of tritium to the air based on updated waste loads would be projected to increase at LLNL. The resulting offsite MEI cancer fatality probability and other risks (e.g., MEI cancer incidence probability), driven by the release of tritium to the air at LLNL, could increase. This increase in tritium releases could also occur at Hanford in Regionalized and Centralized Alternatives, with similar increases in risk when the LLMW at LLNL is shipped to Hanford for treatment. As discussed in the preceding paragraph, mitigation measures would be employed, such as alternative technologies, to maintain safe emission levels (see Appendix I).

6.4.1.6 Probability of MEI Cancer Incidences and Genetic Effects

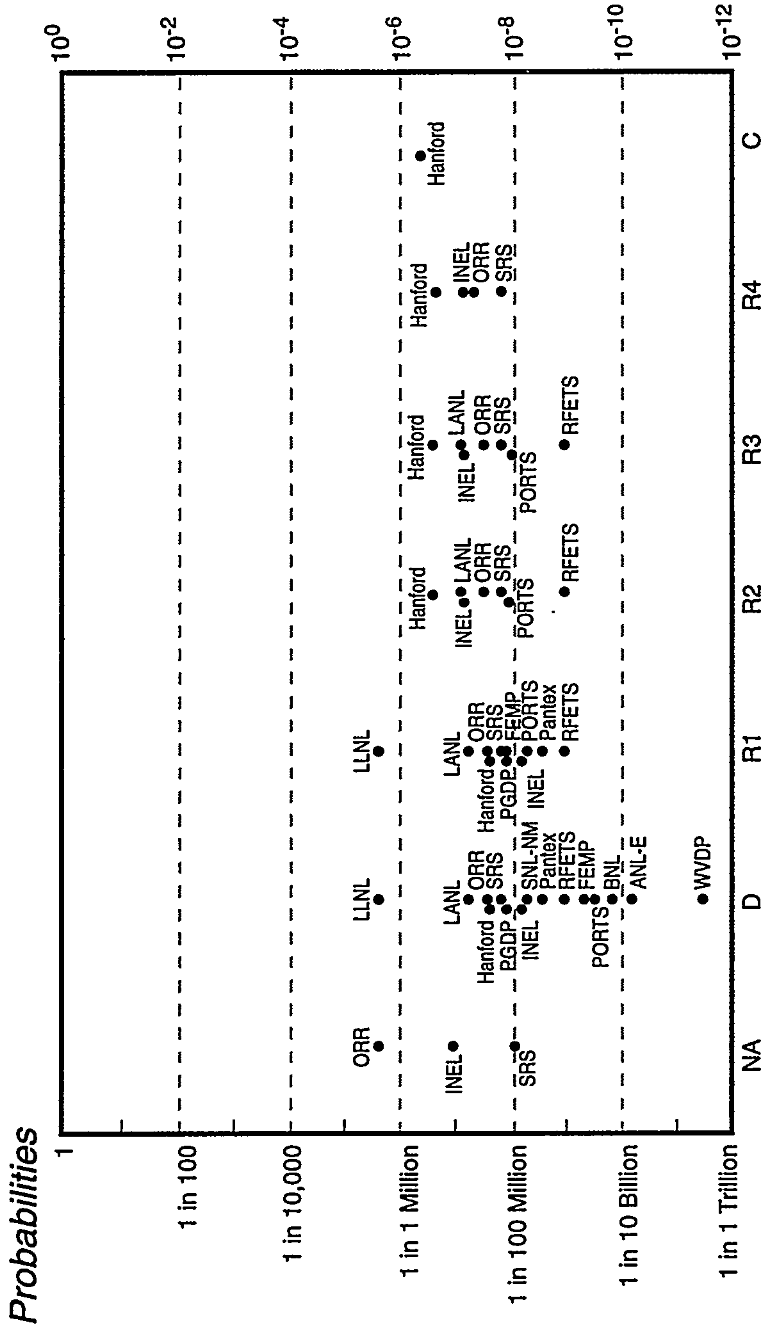
Table 6.4–9 summarizes, by alternative, the highest estimated *probability* at any site of cancer incidences and genetic effects resulting from chemical and radionuclide exposure. The table presents these estimated risks for the MEI of the offsite and the noninvolved worker populations.

The highest radiation cancer incidence probability for the offsite MEI, under each treatment alternative, is greater than the highest chemical cancer incidence probability. The same trend can be seen in the cancer incidence probabilities for the noninvolved worker MEI.

Table 6.4-8. LLMW Treatment—Offsite MEI Cancer Fatality Probabilities

Alternative	Number of Sites T	D	ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
No Action	3	NA	—	—	—	—	7E-08	—	—	—	3E-06	—	—	8E-09	—	—	1E-08	—
Decentralized	37	16	9E-11	2E-10	5E-10	3E-08	7E-09	6E-08	3E-06	2E-10	3E-08	1E-08	3E-09	3E-10	1E-09	5E-09	2E-08	4E-12
Regionalized 1	11	12	—	—	1E-08	3E-08	7E-09	6E-08	3E-06	—	3E-08	1E-08	3E-09	6E-09	1E-09	—	2E-08	—
Regionalized 2	7	6	—	—	—	3E-07	8E-08	9E-08	—	—	4E-08	—	—	1E-08	1E-09	—	2E-08	—
Regionalized 3	7	1	—	—	—	3E-07	8E-08	9E-08	—	—	4E-08	—	—	1E-08	1E-09	—	2E-08	—
Regionalized 4	4	6	—	—	—	3E-07	8E-08	—	—	—	5E-08	—	—	—	—	—	2E-08	—
Centralized	1	1	—	—	—	5E-07	—	—	—	—	—	—	—	—	—	—	—	—

Notes: T = treatment; D = disposal; NA = not applicable; -- = action not applicable for the alternative. Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.



	NA	D	R1	R2	R3	R4	C
Treat at	3 sites	37 sites*	11 sites	7 sites	7 sites	4 sites	1 site
Dispose at		16 sites	12 sites	6 sites	1 site	6 sites	1 site

*15 major sites are shown

Note: Chart in logarithmic scale

Figure 6.4–1. LLMW Treatment—Probability of Cancer Fatality to Offsite MEI

Table 6.4-9. LLMW Treatment—Greatest Probability of Cancer Incidences and Genetic Effects at Any LLMW Site

Alternative	Number of Sites T	Number of Sites D	Offsite MEI Radionuclide Dose (rem)	Offsite MEI Radionuclide Cancer Incidence Probability	Offsite MEI Radionuclide Genetic Effects Probability	Offsite MEI Chemical Cancer Incidence Probability	Noninvolved Worker MEI Radionuclide Dose (rem)	Noninvolved Worker MEI Radionuclide Cancer Incidence Probability	Noninvolved Worker MEI Radionuclide Genetic Effects Probability	Noninvolved Worker MEI Chemical Cancer Incidence Probability
No Action	3	NA	0.007	1E-05	7E-07	2E-08	0.02	3E-05	2E-06	3E-07
Decentralized	37	16	0.005	9E-06	5E-07	1E-09	0.002	3E-06	2E-07	7E-09
Regionalized 1	11	12	0.005	9E-06	5E-07	1E-09	0.002	3E-06	2E-07	6E-09
Regionalized 2	7	6	0.0005	9E-07	5E-08	1E-09	0.0006	1E-06	6E-08	6E-09
Regionalized 3	7	1	0.0005	9E-07	5E-08	1E-09	0.0006	1E-06	6E-08	6E-09
Regionalized 4	4	6	0.0005	9E-07	6E-08	2E-09	0.0006	1E-06	6E-08	9E-09
Centralized	1	1	0.001	2E-06	1E-07	4E-10	0.001	2E-06	1E-07	1E-08

Notes: T = treatment; D = disposal; NA = not applicable. Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

Offsite MEI radiation cancer incidence probability is highest at ORR under the No Action Alternative, at LLNL under the Decentralized and Regionalized 1 Alternatives, and at the Hanford Site under the Centralized Alternative. Uranium-238 is the radionuclide that accounts for most of the risk at ORR under the No Action Alternative, whereas tritium is the controlling radionuclide at LLNL under the Decentralized and Regionalized 1 Alternatives and at the Hanford Site under the Centralized Alternative.

Radiation cancer incidence probability for the noninvolved worker MEI followed a similar pattern. Genetic effects incidence probability is highest at ORR under the No Action Alternative for the offsite MEI and the noninvolved worker MEI.

6.4.1.7 MEI Noncancer Risks

The "Hazard Index" is an EPA standard indicator of potential noncancer chemical health risk. It is derived by comparing the estimated exposure concentrations of noncarcinogenic chemicals to concentrations presumed to not produce adverse human health effects over an entire lifetime, assuming continuous low-level exposure. If the Hazard Index exceeds one, the potential exists for adverse health effects. In this PEIS, the Hazard Index was estimated for the offsite MEI, the noninvolved worker MEI and the hypothetical farm family most exposed lifetime MEI (Section 6.4.1.8).

For waste management workers, an "Exposure Index" rather than a Hazard Index was estimated. The Exposure Index is derived by comparing the estimated exposure concentrations to appropriate occupational exposure limits. The Exposure Index was considered to be a better measure for waste management workers because the Hazard Index uses standards designed to protect the health of the general population, including sensitive subgroups, such as children. Workers are generally assumed to be healthier than the general population, and worker populations do not contain sensitive subgroups. Therefore, the concentrations of noncarcinogenic chemicals presumed to be protective of human health are different for these two groups of receptors. If the Exposure Index exceeds one, the estimated concentrations exceed the concentrations presumed to be without adverse health effects.

Programwide. Table 6.4–10 summarizes, by alternative, the programwide noncancer health risks resulting from chemical exposures associated with each LLMW alternative. This table presents the greatest noncancer health risks (presented as "Hazard Index") to the MEI within the offsite and noninvolved worker receptor groups, and to an individual waste management worker (presented as "Exposure Index") across the treatment sites.

Table 6.4–10. LLMW Treatment—Greatest Noncancer Health Risks From Chemical Exposure at Any LLMW Site

Alternative	Number of Sites		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
	T	D			
No Action	3	NA	*	*	*
Decentralized	37	16	*	*	*
Regionalized 1	11	12	*	*	*
Regionalized 2	7	6	*	*	*
Regionalized 3	7	1	*	*	*
Regionalized 4	4	6	*	*	*
Centralized	1	1	*	*	*

Notes: T = treatment; D = disposal; NA = not applicable; * = greater than 0 but less than 1. Treatment risks under the No Action Alternative include risks from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

No Hazard or Exposure Index values equal or exceed one as a result of treatment operations; therefore, noncancer toxicity is not expected to be of concern for these receptors.

6.4.1.8 Hypothetical Farm Family Risks

In addition to the worker disposal risks already presented, disposal risks were evaluated for hypothetical receptors, a farm family and an intruder, as defined in Section 6.4.1. Risks to both the hypothetical farm family and the hypothetical intruder (Section 6.4.1.10) were analyzed in keeping with the requirements of DOE Order 5820.2A, "Radioactive Waste Management" (DOE, 1988). This order requires that site-specific performance assessments be conducted in order to demonstrate that a given disposal practice is in compliance with the set of performance objectives quantified in the DOE Order. These objectives specify concentrations and dose limits that are intended to be protective of the general public, an inadvertent intruder, and groundwater resources. Releases from the disposal facility occur as the result of natural causes (e.g., through leaching upon breakdown of the facility) and by inadvertent human intrusion.

The farm family scenario addresses potential contamination of groundwater resources as well as the potential health effect consequences of exposure of the general public to radionuclides and chemicals released from the disposal facility. The radionuclides and chemicals are assumed to leach from the disposal site through the unsaturated zone to contaminate groundwater that is used by a future farm family as a source of drinking water and irrigation water. See Section 5.4.1 for a further discussion of the presentation of farm family risk results.

Although the disposal facility risk analyses conducted in this WM PEIS use scenarios that are similar to those used in the performance assessment process, it is important to note that the objectives of the two types of analyses are different. The WM PEIS hypothetical farm family and intruder scenario analyses assume the use of generic disposal facilities and generic waste forms (e.g., grout or polymers), and that the entire inventory of waste will be disposed (i.e., no exclusion of particular radionuclides or chemicals). These assumptions lead to overestimates of contaminant concentrations in groundwater. The objective of the WM PEIS analyses is to provide a relative comparison of potential risk among LLMW management alternatives. The outputs of the analyses are risk estimates for the hypothetical farm family and intruder.

In contrast, the performance assessment analysis process involves the use of more detailed site-specific data in the design of a disposal facility at a particular location on a site. The objective of the analysis is to design a facility that will satisfy the performance objectives specified in DOE Order 5820.2A. These performance objectives include, in practice, (1) modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase adsorption or a concrete cap to reduce infiltration); (2) modifying the form of the waste to be disposed (such as changing to a vitrified waste form); (3) changing the specific location of the waste disposal facility so that it is sited over an area with more favorable hydrologic conditions; and (4) imposing waste acceptance criteria (i.e., restricting the amounts of radionuclides allowed in a given waste disposal facility). The output of the analysis is a set of waste disposal facility design criteria.

As a result of these differences, the WM PEIS analyses produce estimates of groundwater contamination and farm family risk that are higher than those that would be expected upon actual implementation of the LLMW disposal alternatives. For example, the generic WM PEIS analysis estimates that radionuclide groundwater contamination will exceed existing drinking water quality protection standards at certain sites (see Section 6.6.2). However, the drinking water resource protection performance objective contained in DOE Order 5820.2A would require that the waste disposal facility designs developed by the performance assessment analyses subsequently conducted at those sites ensure that drinking water standards would not be exceeded upon disposal of LLMW. Consequently, the hypothetical farm family risk estimates presented in this section have been adjusted to reflect groundwater contamination that does not exceed existing standards. That is, radionuclides whose estimated groundwater concentrations exceeded drinking water standards were adjusted to concentrations that represent 100% of drinking water standards. This assumes that mitigation has taken place and the appropriate groundwater standards will be met. If the standards cannot be met, the facility would fail the performance assessment analysis, and such a facility would not be built. The unadjusted risk estimates from the WM PEIS analysis are presented in the Volume II site tables and in Appendix D.

In addition, the concentrations of hazardous chemicals estimated to be released to groundwater from LLMW disposal facilities have been overestimated in the WM PEIS analyses as a result of assumptions used concerning the routing of wastes through LLMW treatment systems. Conventional technology assumed for pretreatment allowed some wastes containing solvents to bypass the thermal treatment processes used, as shown in the LLMW flow diagram (Figure 6.2-1). Some of the solvents contained in the wastes that would be destroyed by treatment instead remained in the disposed waste in concentrations that were estimated to produce groundwater contamination in excess of standards. In practice, more intensive pretreatment of LLMW would ensure that EPA land disposal restrictions (LDRs) were satisfied. Therefore, LLMW disposal should not produce major impacts to groundwater quality and subsequently to human health. In a manner similar to radionuclides, the WM PEIS analysis estimates of hazardous chemical concentrations were adjusted to levels that did not exceed existing water quality standards.

The results of the hypothetical farm family analyses are presented in Table 6.4–11 for the MEI of the most exposed lifetime.

MEI cancer fatality probability estimates for each site that disposes under the various alternatives are presented in Table 6.4–11. The results of the WM PEIS analysis indicate that disposal of uranium-238 (U-238) must be carefully controlled at FEMP (under the Decentralized and Regionalized 1 Alternatives), the Hanford Site (under the Decentralized, Regionalized 1, 2, and 4, and Centralized Alternatives), and SRS (under the Decentralized and Regionalized 1, 2, and 4 Alternatives). Such controls are likely to result in additional costs and potentially to increased impacts in other resource areas. If the amount or form of U-238 is not controlled as previously described, the groundwater concentrations of the radionuclide at these sites are estimated to exceed drinking water standards. These elevated groundwater concentrations would produce cancer fatality probability estimates that are about four (at FEMP) to 10 (at the Hanford Site and SRS) times higher than those presented in Table 6.4–11 (see Volume II site tables and Appendix D). In a similar manner, the disposal of plutonium-240 (Pu-240) at SNL-NM would require careful control. The estimated times of maximum future radionuclide exposure at these sites are as follows:

- FEMP—U-238 at 4,010 years
- The Hanford Site—U-238 at 1,260 years
- SNL-NM—Pu-240 at 6,440 years
- SRS—U-238 at 11,460 years

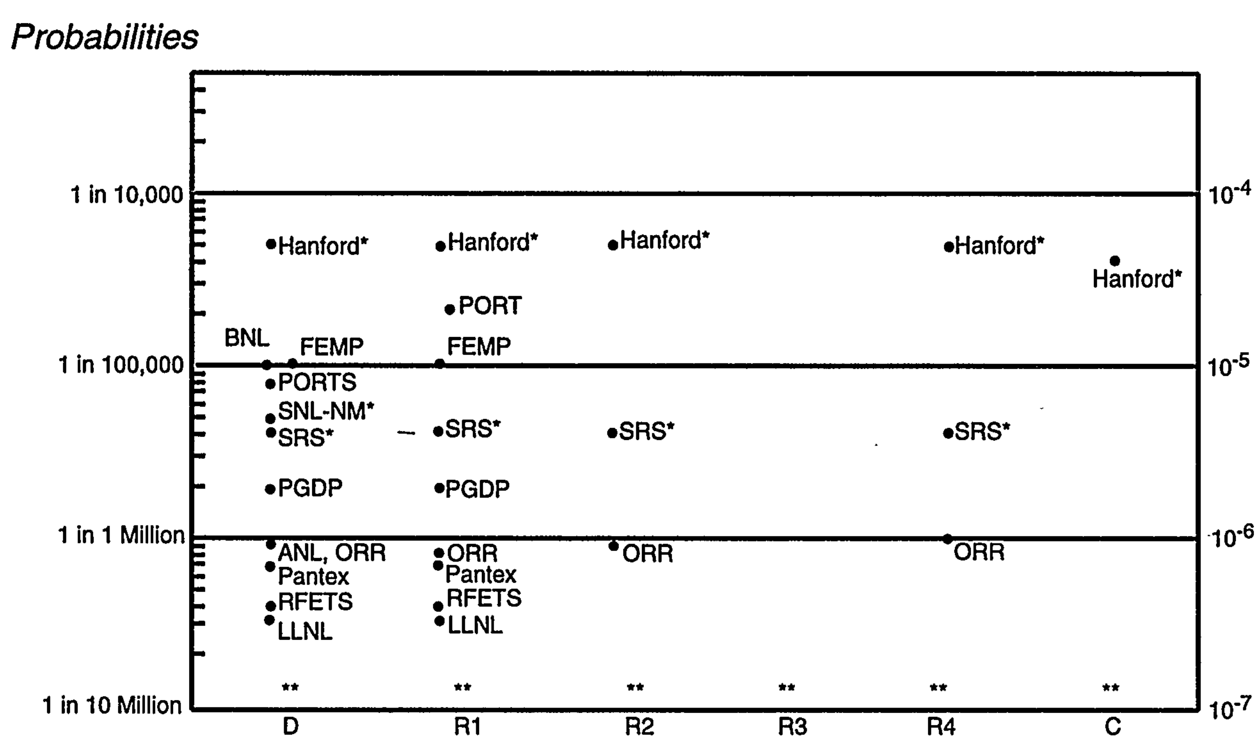
More recent estimates for the release of radionuclides to the groundwater based on updated waste loads project increases in the expected groundwater exceedances for particular radionuclides at these sites: FEMP (U-238), Hanford (U-238), SRS (U-238), and SNL-NM (Pu-240). Other risks associated with the release to the groundwater of these particular radionuclides at these sites could also be expected to increase for unconstrained disposal. Careful management would continue to be a requirement for these radionuclides at these sites (see Appendix I).

The results of this analysis, graphically presented in Figure 6.4–2, also indicate that, on the basis of estimated MEI cancer fatality probability, disposal of LLMW at ANL-E, BNL, INEL, LANL, LLNL, NTS, ORR, PGDP, the Pantex Plant, Portsmouth, and RFETS could be accomplished for

Table 6.4-11. LLMW Disposal: Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probabilities

Alternative	Number of Sites		ANL	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	9E-07	1E-05	1E-05*	5E-05*	~0	~0	3E-07	~0	9E-07	2E-06	7E-07	8E-06	4E-07	5E-06*	4E-06*	--
Regionalized 1	11	12	--	--	1E-05*	5E-05*	~0	~0	3E-07	~0	8E-07	2E-06	7E-07	2E-05	4E-07	--	4E-06*	--
Regionalized 2	7	6	--	--	--	5E-05*	~0	~0	--	--	9E-07	--	--	--	--	--	4E-06*	--
Regionalized 3	7	1	--	--	--	--	--	--	--	~0	--	--	--	--	--	--	--	--
Regionalized 4	4	6	--	--	--	5E-05*	~0	~0	--	--	1E-06	--	--	--	--	--	4E-06*	--
Centralized	1	1	--	--	--	4E-05*	--	--	--	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; -- = action not applicable for alternative; * = adjusted values. They represent the estimated risks when groundwater concentrations of radionuclides are adjusted to 100% of existing standards. Radionuclides that drive risks and exceed drinking water standards include uranium-238 at FEMP, the Hanford Site, and SRS, and plutonium-240 at SNL-NM. Unadjusted risk estimates are presented in the Volume II Site Tables and in Appendix D. At ORR, groundwater concentrations of radionuclides must be adjusted to meet existing standards for disposal of RH LLMW. This occurs under all alternatives except No Action. The cancer fatality probability values for RH-LLMW at ORR are 2E-06 for all disposal alternatives except No Action. These are adjusted values based on plutonium-239 as the risk driver. Cancer fatality probability values for disposal of RH-LLMW at INEL, the Hanford Site and SRS are near zero, 6E-08, and 5E-07, respectively. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.



Treat at	37 sites	11 sites	7 sites	7 sites	4 sites	1 site
Dispose at	16 sites	12 sites	6 sites	1 site	6 sites	1 site

Note: Chart in logarithmic scale

* Adjusted values = see text discussion.

** Waste disposed at INEL, LANL, and/or NTS did not produce a probability of cancer fatality.

At INEL, Hanford, ORR and SRS, the cancer fatality probability values for disposal of RH-LLMW are near zero, 6E-08, 2E-06, and 5E-07, respectively. The value for ORR was adjusted.

ANL-E values are higher than expected.

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Figure 6.4–2. LLMW Disposal—Probability of Cancer Fatality for Hypothetical Farm Family Most Exposed Lifetime MEI

WM PEIS-assumed wastes without additional radionuclide constraints. Of these sites, INEL, LANL, and NTS had the lowest (near zero) estimated cancer fatality probabilities.

Table 6.4–12 presents site-specific estimates of the most exposed lifetime MEI chemical cancer incidence probability. The data in Table 6.4–12 are graphically presented in Figure 6.4–3. The data indicate that, on the basis of chemical cancer incidence probability, 1,2-dichloroethane disposal would need to be controlled at ORR, Portsmouth, and the Hanford Site (under the Centralized Alternative), and that carbon tetrachloride disposal would need to be controlled at RFETS and SRS. The risk estimates presented for these sites in Table 6.4–12 have been adjusted to 100% of drinking water standards for these contaminants. The unadjusted risk estimates are presented in the Volume II site data tables. As previously described, these unadjusted values overestimate potential chemical cancer incidence probability because the pretreatment process stream used in this PEIS allows some solvents to remain in the buried waste, which would not occur upon compliance with EPA LDR requirements.

Noncancer adverse health risks from exposure to chemical contaminants in groundwater were also evaluated. They are of concern under the Decentralized and Regionalized Alternatives. Under Regionalized Alternatives 2 and 4, noncancer health risks are estimated to occur at ORR as a result of exposure to acetone. The acetone groundwater concentrations, like those of the other solvents, could be reduced to acceptable levels by providing more intensive treatment. Therefore, the noncancer risks at ORR under these alternatives could be mitigated. Under the Decentralized and Regionalized 1 Alternatives, noncancer risks occur at Portsmouth as a result of exposure to arsenic. Adjusting chemical contaminant concentrations to comply with drinking water quality standards is necessary to ensure that noncancer risks are not a concern at the Hanford Site (under all alternatives), RFETS (under Decentralized and Regionalized 1 Alternatives), and SRS (under Decentralized and Regionalized 1, 2, and 4 Alternatives). The chemicals that are estimated to drive the noncancer risks at these sites if groundwater concentrations are not adjusted include silver (at the Hanford Site) and carbon tetrachloride (at RFETS and SRS).

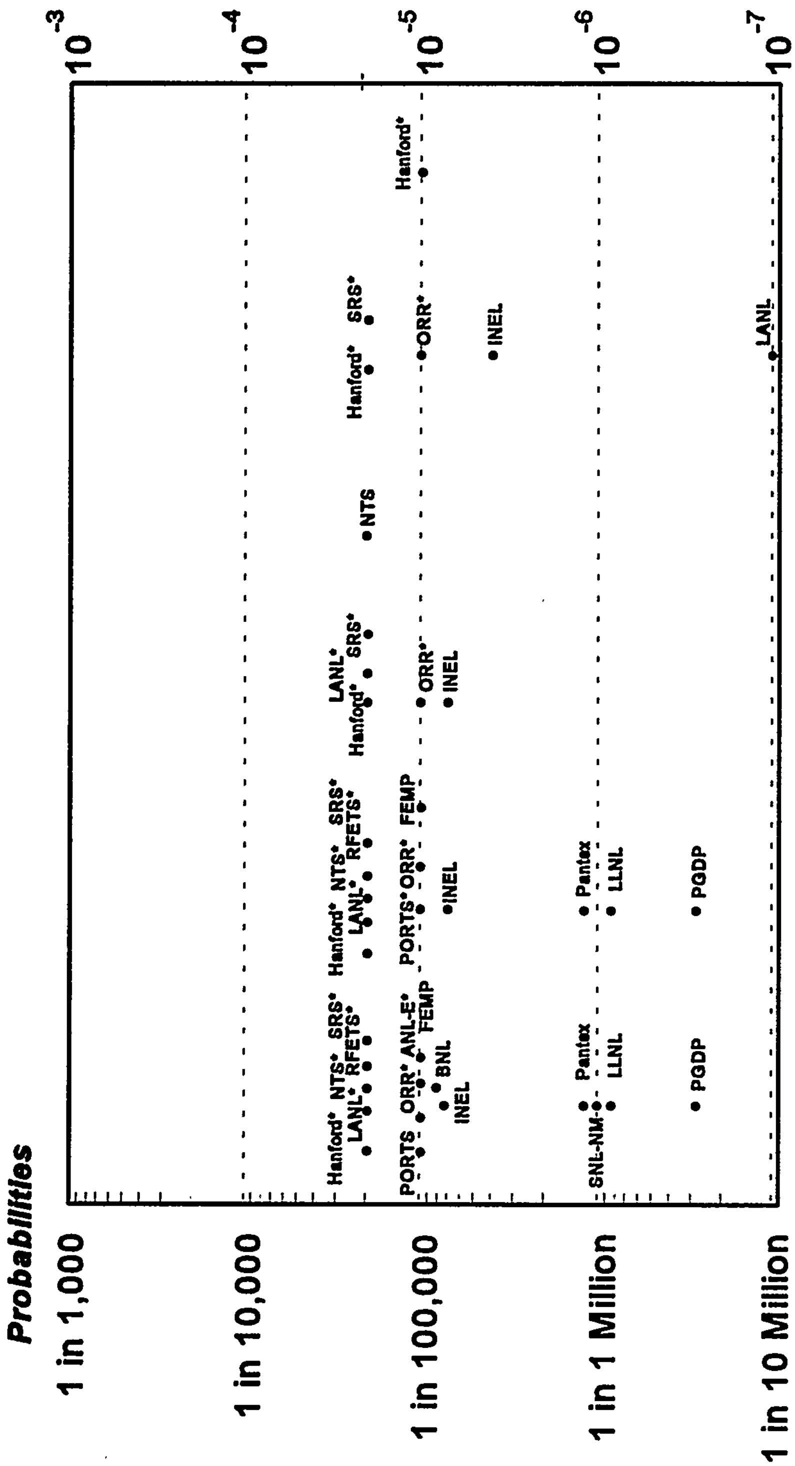
The hypothetical farm family risks represent individual receptors assumed to be exposed through location of a drinking water well at 300 m from the center of a single disposal unit. Concentrations of groundwater contaminants at this location are assumed to be higher than those that could be expected at greater distances from the unit due to dispersion of contaminants. Construction of multiple units is expected to be required at certain sites under the various LLMW alternatives to dispose of the projected waste volumes. While the farm family scenario evaluates only a single receptor 300 m from an individual unit, DOE assumes that each

Table 6.4–12. LLMW Disposal—Chemical Cancer Incidence Probability for Hypothetical Farm Family Most Exposed Lifetime MEI

Alternative	Number of Sites T	Number of Sites D	ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS[a]	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
No Action	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	1E-06	8E-06	1E-05	1E-04	7E-06	8E-05	8E-07	2E-06	1E-04*	3E-07	1E-06	2E-05	2E-04*	9E-07	2E-04*	--
Regionalized 1	11	12	--	--	1E-05	1E-04	7E-06	8E-05	8E-07	2E-06	1E-04*	3E-07	1E-06	3E-05*	2E-04*	--	2E-04*	--
Regionalized 2	7	6	--	--	--	1E-04	8E-06	4E-05	--	--	1E-04*	--	--	--	--	--	2E-04*	--
Regionalized 3	7	1	--	--	--	--	--	--	--	2E-04	--	--	--	--	--	--	--	--
Regionalized 4	4	6	--	--	--	1E-04	4E-06	1E-07	--	--	1E-04*	--	--	--	--	--	2E-04*	--
Centralized	1	1	--	--	--	1E-04*	--	--	--	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; -- = action not applicable for alternative; * = adjusted values. They represent the risks when groundwater concentrations of carcinogenic chemicals are adjusted to 100% of existing standards. Chemicals that drive risks and exceed drinking water standards include 1,2-dichloroethane at ORR, PORTS, and the Hanford Site (under Centralized) and carbon tetrachloride at RFETS and SRS. Unadjusted risk estimates are presented in the Volume II site tables and in Appendix D.

[a] The values for NTS overestimate potential risks at that site, since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years (Sully et al., 1995). Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.



	D	R1	R2	R3	R4	C
Treat at	37 sites	11 sites	7 sites	7 sites	4 sites	1 site
Dispose at	16 sites	12 sites	6 sites	1 site	6 sites	1 site

* Adjusted values - see text discussion

note: chart in logarithmic scale

Figure 6.4–3. LLMW Disposal—Probability of Chemical Cancer Incidence for Hypothetical Farm Family Most Exposed Lifetime MEI of these close-in receptors will be affected primarily by the contaminant plume from the closest facility to him. However, DOE recognizes that commingling of contaminant plumes from multiple disposal units may occur as distance from the units increases, but anticipates that, at 300 m, the highest concentration of contaminants is likely to result from the single closest plume. At greater distances from the disposal units, where overlap of the plumes is more likely, the concentrations in any given plume should be lower as a result of dispersion and dilution than those estimated at the 300-m well. The WM PEIS cannot address groundwater contaminant concentrations at distances greater than 300 m from disposal units. More detailed analyses, such as the performance assessments required under DOE Order 5820.2A, will address the issues of existing groundwater contamination and multiple disposal units. For example, in April 1996, DOE issued guidance for the conduct of composite analyses in addition to performance assessments to help ensure that continuing disposal of low-level waste will not compromise the future radiological protection of the public. The composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from an active or planned low-level waste disposal facility and other sources of radioactive material in the ground that might interact with the LLW disposal facility.

6.4.1.9 Potential Collective Risk to Offsite Population From Waste Disposal

Risk assessments generally evaluate both collective and individual health risks, that is, risks for both populations of receptors and for MEIs. However, the WM PEIS disposal risk analysis quantitatively estimates risks only for the farm family MEI. Although the farm family scenario disposal risk analysis uses site-specific hydrogeologic and meteorologic data, use of "conceptual" disposal units was assumed. The analysis did not attempt to identify exact locations of these generic units on a site; rather, they were assumed to be placed either near existing disposal units where such units existed, or at a location on the site expected to be most sensitive to groundwater contamination. Since the analysis does not attempt to actually locate the disposal units on the site, DOE believes it is not possible to develop plausible quantitative estimates of the collective risks to current or future offsite populations resulting from exposure to contaminated groundwater. Both the concentrations of contaminants in the groundwater and the number of people potentially exposed will be strongly influenced by the locations of the disposal units and receptor wells. A hypothetical siting decision to support such an analysis is not favored because the choice of a site so strongly influences the results as to make them a direct reflection of the choice.

To address the relative potential of the proposed disposal sites and alternatives for collective risk to offsite populations, values for site parameters that influence potential groundwater contamination or that are associated with the relative size of populations at risk were statistically analyzed. These variables included the size of the site (acres), depth to aquifer, the size of the offsite population living within 50 miles of the site, annual rainfall, annual groundwater recharge, and time of travel of groundwater from the surface to a downgradient well. Statistical analysis of these variables produced clusters or groupings of sites according to their relative potential risk vulnerability. These groupings are believed to be more appropriate metrics for decision making, given the lack of facility siting and other relevant information, than quantitative estimates of person-rem doses and latent cancer fatalities.

Section C.4.1 of Appendix C contains additional information about the methodology and results of the collective risk vulnerability analysis. This section also describes other DOE efforts to assess potential risks from waste disposal, including those of the Federal Facility Compliance Act Disposal Workgroup and the performance assessment process required by DOE Order 5820.2A.

Section 5.4.1 of Chapter 5 contains a discussion of the results of the collective risk vulnerability analysis. Candidate disposal sites are grouped into three population risk vulnerability (PRV) groups, with PRV Group 1 having the lowest potential vulnerability for offsite population risks from groundwater contamination following LLMW disposal, and PRV Group 3 having the highest potential. The results of this analysis generally agree with those of the Federal Facility Compliance Act Disposal Workgroup analysis of potential radionuclide exposure via the groundwater pathway, as presented in the report, *Performance Evaluation of the Technical Capabilities of DOE Sites for Disposal of Mixed Low-Level Waste* (DOE 1996d). It is important to note that this is a screening-level analysis that does not take into account any measures that would limit migration of disposed wastes into the groundwater, such as engineered disposal units or changes in waste acceptance criteria. The objective of the analysis is not to rule out any sites for disposal but to indicate where such disposal mitigation measures are more likely to be necessary and where the costs of disposal would likely increase as a result. In particular, though some sites may be listed in Group 3, this does not mean that disposal would be unacceptable there. Rather, it means that mitigation would be an important part of a disposal plan for these sites.

As previously described, the waste volume, curie load, chemical volume, and number of potential disposal units required at a given site vary by waste management alternative. Table 6.4–13 presents data on disposal volumes, number of disposal units, curies, and chemical inventories for each site as they vary over the proposed alternatives, in conjunction with the results of the risk vulnerability factor and cluster analyses. This information is summarized across the sites for each alternative and displayed in Table 6.4–14. The

Table 6.4-13. Disposal Variables (by Site and Alternative) and Population Risk Vulnerability Group for LLMW

Disposal Alternative Variables	ANL-E[b]	BNL	FEMP	Hanford[a]	INEL[a]	LANL	LLNL	NTS[b]	ORR[a]	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS[a]	WVDP
Risk Vulnerability Group	2	2	3	1	1	1	2	1	3	3	1	3	2	2	3	2
Decentralized Alternative																
Number of disposal units	1	1	1	2	1	1	1	1	2	1	1	1	2	1	1	1
Disposal waste volume (m^3)	30	84	1,080	12,500	6,550	670	1,870	2,980	20,400	220	200	5,910	13,900	14	5,520	0
Total radioactivity (Ci × 0.001)	0.039	0.085	0.013	52	126	1.1	17.9	26	24	0.98	0.17	3.5	0.29	0.08	24	0
Total chemical inventory (kg × 0.001))	0.20	1.2	8.2	88	103	9.1	7.8	5.8	189	1.4	0.95	98	75	0.15	51	0
Regionalized 1 Alternative																
Number of disposal units			1	2	1	1	1	1	2	1	1	1	2		1	
Disposal waste volume			1,080	12,500	8,630	690	1,870	900	20,040	220	200	6,020	13,900		5,520	
Total radioactivity (Ci × 0.001)			0.013	52	128	1.2	17.9	24	24	0.98	0.17	3.6	0.29		24	
Total chemical inventory (kg × 0.001)			8.2	88	106	9.2	7.8	2.9	189	1.4	0.95	99	75		51	
Regionalized 2 Alternative																
Number of disposal units				2	1	2			3						1	
Disposal waste volume				13,300	9,530	14,800			27,700						5,520	
Total radioactivity (Ci × 0.001)				70	152	1.7			28						24	
Total chemical inventory (kg × 0.001)				96	109	85			297						51	
Regionalized 3 Alternative																
Number of disposal units								9								
Disposal waste volume								70,850								
Total radioactivity (Ci × 0.001)								276								
Total chemical inventory (kg × 0.001)								638								

Table 6.4-13. Disposal Variables (by Site and Alternative) and Population Risk Vulnerability Group For LLMW—Continued

Disposal Alternative Variables	ANL-E[b]	BNL	FEMP	Hanford[a]	INEL[a]	LANL	LLNL	NTS[b]	ORR[a]	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS[a]	WVDP
Regionalized 4 Alternative																
Number of disposal units				2	3				3						1	
Disposal waste volume				13,300	24,320				27,700						5,520	
Total radioactivity (Ci × 0.001)				70	154				28						24	
Total chemical inventory (kg × 0.001)				96	197				297						51	
Centralized Alternative																
Number of disposal units				9												
Disposal waste volume				70,850												
Total radioactivity (Ci × 0.001)				276												
Total chemical inventory (kg × 0.001)				638												

[a] Total radioactivity (curies) for remote-handled (RH) LLMW associated with the waste at Hanford (9), INEL (220,000), ORR (324,000), and SRS (4,920) for all the action alternatives are not included within the table.

[b] NTS and ANL-E are sites that have been analyzed using newer information (see Appendix I). NTS also accepts waste for disposal from sites whose analysis is based on data from an earlier database. Thus, the information on disposal at NTS is a composite of data obtained from both sources. This affects the analysis (to a lesser extent) of any disposal site in any alternative that accepts waste for disposal from NTS and ANL-E.

Table 6.4-14. Disposal Variables by LLMW Alternative and Population Risk Vulnerability Group

Alternative	Group 3	Group 2	Group 1
Decentralized Alternative			
Number of disposal units	6	5	8
Disposal waste volume (m^3)	33,100	1,908	36,800
Total radioactivity (Ci × 0.001)	52.5	18.1	205.6
Total chemical inventory (kg × 0.001)	347.6	9.3	281.8
Regionalized 1 Alternative			
Number of disposal units	6	1	8
Disposal waste volume (m^3)	33,240	1,870	36,800
Total radioactivity (Ci × 0.001)	52.6	17.9	205.1
Total chemical inventory (kg × 0.001)	348.6	7.8	282.0
Regionalized 2 Alternative			
Number of disposal units	4	0	5
Disposal waste volume (m^3)	33,220	0	37,630
Total radioactivity (Ci × 0.001)	52.0	0	223.7
Total chemical inventory (kg × 0.001)	348.0	0	290.0
Regionalized 3 Alternative			
Number of disposal units	0	0	9
Disposal waste volume (m^3)	0	0	70,850
Total Radioactivity (Ci × 0.001)	0	0	276.0
Total chemical inventory (kg × 0.001)	0	0	638.0
Regionalized 4 Alternative			
Number of disposal units	4	0	5
Disposal waste volume (m^3)	33,220	0	37,620
Total radioactivity (Ci × 0.001)	52.0	0	224.0
Total chemical inventory (kg × 0.001)	348.0	0	293.0
Centralized Alternative			
Number of disposal units	0	0	9
Disposal waste volume (m^3)	0	0	70,850
Total radioactivity (Ci × 0.001)	0	0	276.0
Total chemical inventory (kg × 0.001)	0	0	638.0

Note: Total radioactivity (curies) for remote-handled (RH) LLMW associated with the waste at Hanford (9), INEL (220,000), ORR (324,000), and SRS (4,920) for all the action alternatives are not included within the table.

summary data in Table 6.4–14 suggest that the Regionalized 3 and Centralized Alternatives present lower potential collective risk to offsite populations from disposal than the Decentralized or other Regionalized Alternatives.

Note that the results of this screening-level risk vulnerability analysis are useful in discussing the relative potentials among the sites and the proposed waste management alternatives. However, more refined risk analyses will be included in the site-specific performance assessments that will be conducted for the design and siting of new disposal facilities. In addition, DOE will consider a number of other factors in the development of waste disposal decisions. These include the results of safety analyses for disposal facility operation, the extent of existing contamination or waste disposal at a site, the costs and benefits involved in transporting waste among sites, and other environmental and socioeconomic concerns.

6.4.1.10 Disposal Intruder Scenario Risks

Table 6.4–15 presents an overview, by alternative, of the greatest programwide risks to a hypothetical intruder 100 and 300 years after the disposal facility has closed. Because the focus is on an individual intruder, the risks are presented as the *probability* of that individual experiencing an adverse health impact

Table 6.4–15 LLMW Disposal: Summary Risks to Hypothetical Intruders at LLMW Sites

			Radionuclide				Chemical	
Alternative	**T**	**D**	**Dose (rem)**	**Cancer Fatality Probability**	**Cancer Incidence Probability**	**Genetic Effects Probability**	**Cancer Incidence Probability**	**Hazard Index[a]**
100 Years After Disposal Facility Closure								
Decentralized	37	16	34	2E–02	6E–02	3E–03	2E–13	1E–07
Regionalized 2	7	6	33	2E–02	6E–02	3E–03	2E–13	1E–07
Centralized	1	1	[illegible]7	4E–03	1E–02	7E–04	5E–14	1E–07
RH-LLMW	4	4	68	3E–02	1E–01	7E–03	1E–14	9E–09
300 Years After Disposal Facility Closure								
Decentralized	37	16	0.7	4E–04	1E–03	7E–05	2E–13	1E–07
Regionalized 2	7	6	0.6	3E–04	1E–03	6E–05	2E–13	1E–07
Centralized	1	1	0.2	7E–05	3E–04	2E–05	5E–14	1E–07
RH-LLMW	4	4	[illegible]2	1E–03	4E–03	2E–04	1E–14	9E–09

Notes: T = treatment; D = disposal.
[a] Maximum of values for each site evaluated under the alternative.

(assuming that the intrusion occurs) rather than a total number of impacts for a selected population. Note that the intruder scenario risks were not estimated for all alternatives. Regionalized Alternative 2 was selected to be representative of the Regionalized Alternatives with disposal at six sites.

For both the 100-year and 300-year scenarios, each of the evaluated alternatives is estimated to result in relatively high maximum probabilities of cancer fatality, cancer incidence, and genetic effects from radionuclide and direct radiation exposure. Chemical exposures are much lower, resulting in lower risks of cancer incidence or adverse noncancer health effects.

Table 6.4–16 presents the cancer fatality probabilities by site for each of the alternatives evaluated 100 years and 300 years after the disposal facility has closed. The data in Table 6.4–16 are graphically presented in Figure 6.4–4. Under the Decentralized Alternative, cancer fatality probability values span a range of about four orders of magnitude. Cancer fatality probabilities generally are lower for the 300-year scenario by one to two orders of magnitude (i.e., 10–100 times) under all alternatives, which suggests that risks decrease as radionuclides decay. Strontium-90 (half-life 29 years) was the main radionuclide risk driver at 100 years, under each of the alternatives evaluated, whereas thorium-232 (half-life 1E+10 years), nickel-63 (half-life 96 years), and americium-241 (half-life 432 years) were the main risk drivers at 300 years. There is no general trend in intruder risk among the disposal alternatives evaluated.

The estimated doses presented in Tables 6.4–16 exceed the DOE Order 5820.2A performance assessment objective limits for intruders of 100 millirem per year for continuous exposure at the Hanford Site and INEL under the Decentralized and Regionalized 2 Alternatives and 500 millirem per year for acute exposure at ORR for RH-LLMW. Similar to the discussion in Section 6.4.1.8, site-specific considerations during design, construction, and operation would be expected to mitigate these exceedances. These mitigation measures are also described in Chapter 12.

6.4.2 Transportation-Related Impacts

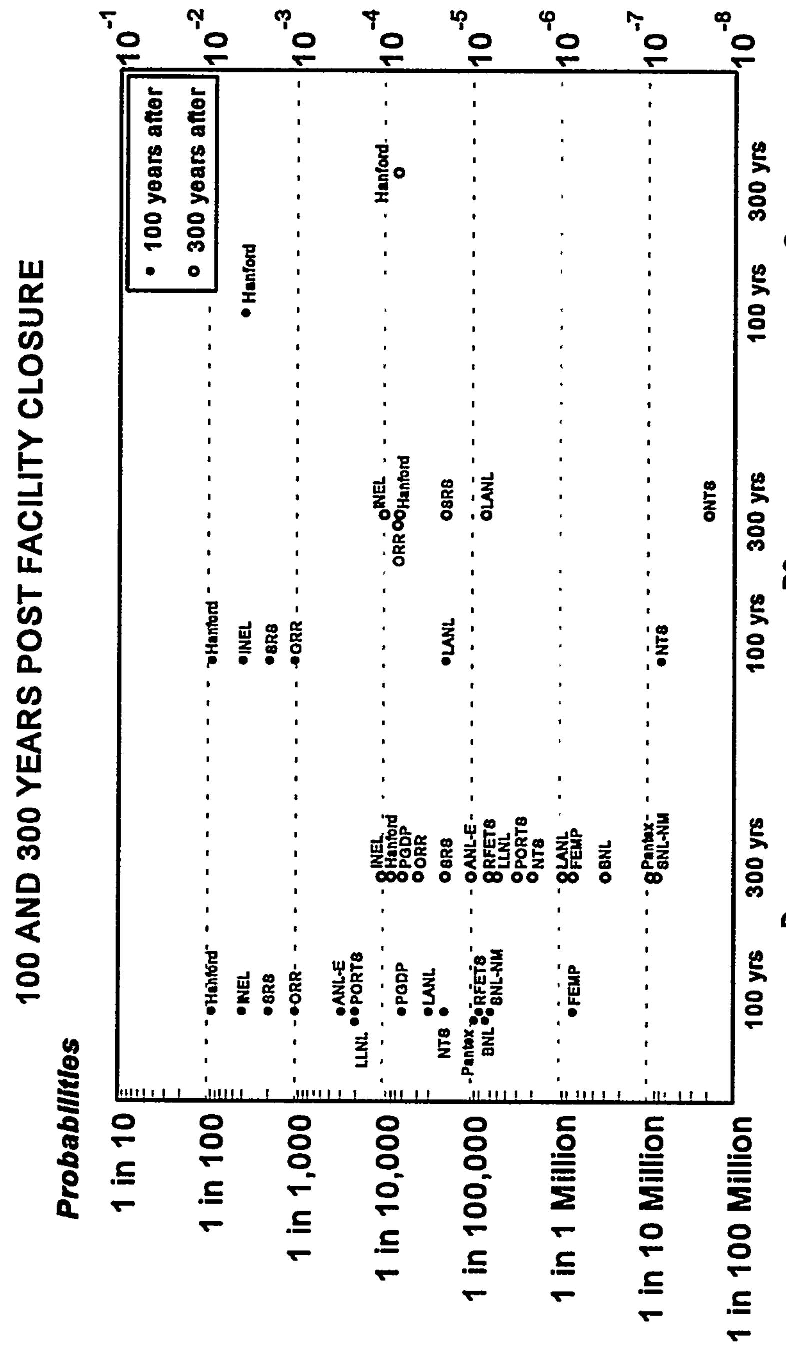
Transporting LLMW for treatment and disposal may affect the health of the truck or rail crew and the public along the transportation route. These impacts are the result of radiation exposure during normal operations, accidents in which the waste containers are assumed to be opened, exposure to vehicle exhaust during transport, and physical injury from vehicle accidents. In the No Action Alternative, no wastes are

Table 6.4–16 LLMW Disposal: Hypothetical Intruder Cancer Fatality Probabilities 100 and 300 Years After Facility Closure[a]

Sites	Decentralized Alternative				Regionalized Alternative 2				Centralized Alternative			
	100 Years		300 Years		100 Years		300 Years		100 Years		300 Years	
	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)	Cancer Fatality Probability	Radiation Dose (rem)
ANL-E	3E-04	6.6E-01	1E-05	2.3E-02	--	--	--	--	--	--	--	--
BNL	7E-06	1.5E-02	3E-07	5E-04	--	--	--	--	--	--	--	--
FEMP	7E-07	1E-03	7E-07	1.4E-03	--	--	--	--	--	--	--	--
Hanford	9E-03	1.9E+01	8E-05	1.5E-01	9E-03	1.9E+01	7E-05	1.4E-01	4E-03	7.1E+00	7E-05	1.5E-01
INEL	4E-03	7.5E+00	1E-04	2.5E-01	4E-03	7.9E+00	1E-04	2.6E-01	--	--	--	--
LANL	3E-05	5.2E-02	9E-07	1.9E-03	2E-05	4.6E-02	7E-06	1.4E-02	--	--	--	--
LLNL	2E-04	3.2E-01	5E-06	9.3E-03	--	--	--	--	--	--	--	--
NTS	2E-05	4.9E-02	2E-06	3.1E-03	7E-08	1E-04	2E-08	3E-04	--	--	--	--
ORR	1E-03	2.6E+00	4E-05	8.5E-02	1E-03	2.5E+00	7E-05	1.5E-01	--	--	--	--
PGDP	6E-05	1.3E-01	6E-05	1.3E-01	--	--	--	--	--	--	--	--
Pantex	9E-06	1.9E-02	9E-08	2E-04	--	--	--	--	--	--	--	--
PORTS	2E-04	4.8E-01	3E-06	6E-03	--	--	--	--	--	--	--	--
RFETS	8E-06	1.6E-02	6E-06	1.1E-02	--	--	--	--	--	--	--	--
SNL-NM	6E-06	1.1E-02	8E-08	2E-04	--	--	--	--	--	--	--	--
SRS	2E-03	3.1E+00	2E-05	4.6E-02	2E-03	3.1E+00	2E-05	4.6E-02	--	--	--	--

Notes: -- = action not applicable for alternative.
[a] Results are provided for contact-handled wastes. Remote-handled LLMW results (all alternatives) are shown in the table below.

Sites	100 Years		300 Years	
	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)
Hanford	3E-06	6E-03	2E-08	5E-05
INEL	6E-03	1.3E+01	1E-04	3E-01
ORR	3E-02	6E+01	1E-03	2E+00
SRS	4E-05	7E-02	5E-07	1E-03



Treat at	37 sites	7 sites	1 site
Dispose at	16 sites*	6 sites	1 site

*15 major sites are shown

note: chart in logarithmic scale

Figure 6.4-4. LLMW Disposal—Hypothetical Intruder Cancer Fatality Probabilities shipped between sites. For all other alternatives, shipments were assumed to occur uniformly over a 10-year period.

The methods used to estimate transportation risk and the risks to the public along the transportation routes are described in Appendix E. Tables 6.4–17 and 6.4–18 present the total number of estimated fatalities associated with truck and rail transportation of LLMW, respectively. The total number of estimated fatalities resulting from radiation exposure and from nonradiological causes (i.e., vehicle exhaust-induced cancers and physical injury resulting from accidents) is less than one when LLMW is transported by rail (Table 6.4–18). The total number of radiological fatalities for truck transportation is also estimated to be less than one (Table 6.4–17). However, the number of fatalities for truck transportation is estimated to be approximately one for Regionalized Alternative 3 and the Centralized Alternative as a result of physical injuries received during traffic accidents.

The health impacts associated with exposure to the hazardous chemical components of LLMW that are released during transportation accidents are presented in Appendix E.

6.4.3 Facility Accident Impacts

6.4.3.1 Storage Facility Accidents

Accidents and source terms for current storage of LLMW were not analyzed explicitly. Unlike treatment, which will predominantly use new facilities that will have common characteristics, current (pretreatment) storage will use a variety of predominantly preexisting facilities that vary greatly in the amounts and types of waste inventories stored, the configurations in which they are stored, and the containment or confinement characteristics of the storage buildings or enclosures. However, recent DOE safety analysis reports (SARS) and NEPA information provide guidance on the potential risk impacts applicable to LLMW and TRUW storage facility accidents.

Information in these current SARs and DOE site EISs can be used as valid indicators of the predicted consequences for a range of waste storage facility accidents of varying frequency. A brief summary of some of the key accidents and assumptions used by the sites in preparing these analyses, and the related health

Table 6.4–17. LLMW Truck Transportation—Estimated Fatalities From Vehicular Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Number of Shipments	Shipment Miles (in Millions)	Estimated Number of Radiological Fatalities[a]		Estimated Number of Nonradiological Fatalities	
	T	D			Normal Operations Public	Normal Operations Crew	Fuel Emission	Injury From Traffic Accidents
No Action	3	NA	0	0	0	0	0	0
Decentralized	37	16	480	0.3	*	*	*	*
Regionalized 1	11	12	1,820	0.6	*	*	*	*
Regionalized 2	7	6	5,560	3	*	*	*	*
Regionalized 3	7	1	10,990	15	*	*	*	1
Regionalized 4	4	6	4,250	3	*	*	*	*
Centralized	1	1	7,520	14	*	*	*	1

Notes: T = treatment; D= disposal; * = greater than 0 but less than 0.5; NA = not applicable.
[a] Fatalities are from radiation-induced cancer.

Table 6.4–18. LLMW Rail Transportation—Estimated Fatalities From Rail Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Number of Shipments	Shipment Miles (in Millions)	Estimated Number of Radiological Fatalities[a]		Estimated Number of Nonradiological Fatalities	
	T	D			Normal Operations Public	Normal Operations Crew	Fuel Emission	Injury From Traffic Accidents
No Action	3	NA	0	0	0	0	0	0
Decentralized	37	16	350	0.2	*	*	*	*
Regionalized 1	11	12	1,030	0.5	*	*	*	*
Regionalized 2	7	6	2,490	1.4	*	*	*	*
Regionalized 3	7	1	4,540	6.8	*	*	*	*
Regionalized 4	4	6	2,050	1.6	*	*	*	*
Centralized	1	1	3,340	6.5	*	*	*	*

Notes: T = treatment; D= disposal; * = greater than 0 but less than 0.5; NA = not applicable.
[a] Fatalities are from radiation-induced cancer.

effects results, are shown in Appendix F. Examples of results applicable to LLMW storage facilities include accidents ranging from violent single drum breaches to large fires in Centralized facilities. The recent SARs and EISs that are relevant focus on TRUW accidents more than LLMW due to TRUW's higher radioactivity. However, the accident scenarios, estimates of airborne material releases due to the accidents, and atmospheric dispersion and health effects calculations are analogous. As a result, LLMW storage facility accident results can be directly related to TRUW facility analyses.

The most relevant recent analyses dealing with postulated accidents for LLMW and TRUW storage facilities were reviewed. Numerous accident scenarios were analyzed (e.g., fires, earthquakes, explosions, etc.). Predicted radiological doses to the MEI ranged from about 10 millirem per accident to about 3 rem for a severe TRUW facility accident (the effects of the latter accident exceeded those from all LLMW facility accidents). When multiplied by the risk conversion factor of 0.0005 latent cancer fatalities per person-rem of exposure (ICRP, 1990), the resultant estimated incremental cancer fatality risk to the MEI would range from about 5E-06 to 2E-03 if the accident were to occur. However, note that the accident frequencies in the reviewed documents ranged from greater than 1E-02 per year for the lower consequence accidents to less than 1E-06 per year for the high consequence accidents. Although there is considerable variation in the assumptions used by the various DOE sites in these recent studies to develop accident scenarios and predicted impacts, public risk from LLMW storage accidents should be very low.

It should be noted that explicitly analyzing risks from storage would not help to discriminate among alternatives because of the assumption used in the WM PEIS for estimating the treatment throughputs that dictate the inventories to be stored before treatment. This assumption is that all sites will accumulate or at least not reduce these inventories for roughly 10 years, at which time the complexwide treatment will begin. Thus, all sites will achieve their maximum inventories (leading to maximum potential releases during a storage facility accident) independent of alternative.

6.4.3.2 Treatment Facility Accidents

Although there are many processes used for treating LLMW, to date, thermal treatment technologies have been most effective in destroying the combustible hazardous constituents contained in LLMW. Since significant incineration data are available, public interest is heightened, and results achieved through incineration are representative and bounding of other thermal treatment processes, this risk analysis focused on incineration. Like other LLMW treatment processes, incineration operations/accidents can result in airborne releases of radionuclides. Potential treatment facility accidents identified for all LLMW alternatives include: (1) incineration facility fires or explosions initiated from internal causes; (2) an earthquake or tornado that causes damage and possible fires in the facility; and (3) the crash of a large or small aircraft into the facility, resulting in fire and possible explosion. All of these accidents can involve release of the radioactive contents of the kiln, the stored ash byproduct of the incineration process, or the trapped contents of the filtration systems in the facility. The accident with the highest potential consequence at each site was evaluated.

The radiological risk and chemical health effects calculations were based upon conservative assumptions. Table 6.4–19 summarizes the estimated doses and cancer fatalities resulting from radiation exposures associated with potential treatment facility accidents. This table contains cancer fatality estimates for the maximum reasonably foreseeable accidents with the highest potential consequences at each site and the estimated frequency of those accidents occurring in any one year. The doses indicated are a function of the severity of the accident and the size and distribution of the population affected. The indicated probabilities of an excess cancer are based on the assumption that the accident occurs. Consistent with standard practice in radiological safety analysis, the fatalities are derived only from the cancers associated with radiation. In general, local worker fatalities in severe accidents from trauma would primarily result from the initiation of the accident, e.g., the initial impact and fire of an airplane crash. These trauma fatalities would tend to be independent of the inventory or process characteristics of a particular site for a given consolidation alternative, and therefore would not tend to be a significant discriminator among the alternatives. Trauma fatalities to the offsite populations from severe accidents would be almost totally independent of the site consolidation and process characteristics that are driven by alternative selection and also would not discriminate among alternatives.

Assuming that the accident occurs, none of the alternatives is estimated to result in a cancer fatality at any site to members of offsite populations or workers. Each of the alternatives poses a cancer fatality probability of greater than one in one million for the offsite MEI. Under the No Action Alternative, the cancer fatality probability is estimated to be greater than one in one million for the indicated accident affecting the offsite MEI at ORR. Under Regionalized Alternatives 2, 3 and 4, an offsite MEI cancer fatality probability of greater than one in one million is estimated for accidents at the Hanford Site and ORR. Under the Decentralized Alternative, 4 sites (the Hanford Site, LLNL, ORR and PGDP) are estimated to have offsite MEI cancer fatality risks greater than one in one million. The Regionalized Alternative 1 is expected to have an offsite MEI cancer fatality probability of greater than one in one million for the assumed accident at

Table 6.4–19. LLMW Facility Accidents—Radiation-Induced Cancer Fatalities From Maximum Reasonably Foreseeable Potential Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Radiation Dose (rem)	Offsite MEI Cancer Fatality Probability	Population Radiation Dose (person-rem)	Offsite Population Number of Cancer Fatalities	Worker Radiation Dose (person-rem)	WM Workers Number of Cancer Fatalities
No Action								
INEL	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-04	1E-07	1E+00	*	2E-01	*
ORR	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	5E-06	2E+02	*	1E+01	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	5E-04	3E-07	2E+01	*	4E+00	*
Decentralized Alternative								
ANL-E	Nonalpha, natural phenomena	1E-06 to 1E-04	6E-05	3E-08	2E+00	*	7E-03	*
BNL	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-03	9E-07	2E+01	*	2E-02	*
FEMP	Nonalpha, natural phenomena	1E-06 to 1E-04	8E-06	4E-09	4E-02	*	2E-04	*
Hanford	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	6E-06	6E+02	*	2E+01	*
INEL	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	4E+00	*	8E+00	*
LANL	Alpha, natural phenomena	1E-06 to 1E-04	8E-04	4E-07	2E+00	*	5E-01	*
LLNL	Nonalpha, natural phenomena	1E-06 to 1E-04	4E-03	2E-06	2E+01	*	3E-01	*
NTS	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-04	9E-08	5E-01	*	3E+00	*
ORR	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-02	1E-05	4E+02	*	3E+01	*
Pantex	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-04	6E-08	1E+00	*	1E-02	*
PGDP	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-02	9E-06	6E+01	*	5E+00	*
RFETS	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	1E+01	*	1E+00	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-03	6E-07	4E+01	*	8E+00	*
Regionalized Alternative 1								
INEL	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	4E+00	*	8E+00	*
LANL	Alpha, natural phenomena	1E-06 to 1E-04	8E-04	4E-07	2E+00	*	5E-01	*
LLNL	Nonalpha, natural phenomena	1E-06 to 1E-04	4E-03	2E-06	2E+01	*	3E-01	*
RFETS	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	1E+01	*	1E+00	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	5E-08	4E+00	*	3E-01	*
Regionalized Alternatives 2 & 3								
Hanford	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	6E-06	6E+02	*	3E+01	*
INEL	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	4E+00	*	8E+00	*
LANL	Alpha, natural phenomena	1E-06 to 1E-04	8E-04	4E-07	2E+00	*	5E-01	*
ORR	Nonalpha, natural phenomena	1E-06 to 1E-04	4E-02	2E-05	4E+02	*	5E+01	*
RFETS	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	1E+01	*	1E+00	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-03	6E-07	4E+01	*	8E+00	*
Regionalized Alternative 4								
Hanford	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-02	6E-06	6E+02	*	3E+01	*
INEL	Alpha, natural phenomena	1E-06 to 1E-04	4E-04	2E-07	4E+00	*	1E+01	*
ORR	Nonalpha, natural phenomena	1E-06 to 1E-04	4E-02	2E-05	4E+02	*	3E+01	*
SRS	Nonalpha, natural phenomena	1E-06 to 1E-04	1E-03	6E-07	4E+01	*	8E+00	*
Centralized Alternative								
Hanford	Nonalpha, natural phenomena	1E-06 to 1E-04	2E-02	9E-06	8E+02	*	3E+02	*

Notes: * = greater than 0 but less than 0.5. Natural phenomena refer to accidents initiated either by earthquake or by high wind or tornado, depending on the site and the associated recurrence frequencies. Incineration was the thermal treatment analyzed. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

LLNL. The Hanford Site and ORR have the highest offsite MEI cancer fatality risk under each of the alternatives, with the exception of the Regionalized Alternative 1. However, when the frequencies of the accidents are considered, none of the alternatives pose an offsite MEI cancer risk of greater than one in one million.

Table 6.4–20 summarizes the estimated cancer incidences and noncancer risks resulting from chemical exposures associated with potential treatment facility accidents. This table contains cancer incidence and noncancer risk estimates for a maximum reasonably foreseeable accident at each site and the estimated annual accident frequency. As with the previous tables, only the cancer incidence and noncancer risks from chemical exposures are presented; fatalities resulting from physical hazards directly associated with the accident are not included. The overall risk from these potential chemical exposures, when the frequency of the assumed accidents is considered, is very small.

None of the alternatives is estimated to result in cancer incidence equal to or greater than one within the offsite population as a result of chemical exposures. For the offsite MEI, cancer incidence probability is not estimated to exceed one in one million for any site. None of the alternatives is estimated to result in cancer incidence equal to or greater than one within the waste management worker population as a result of chemical exposure. Each of the alternatives has noncancer risks above acceptable levels for the most exposed waste management worker with IDLH (Immediately Dangerous to Life and Health) Index values equal to or greater than one for all sites. Accidents at ORR and Portsmouth also result in noncancer risks to the offsite MEI.

It is also important to note that use of the latest safety analysis documentation (described in the preceding section on storage facility accidents) would reduce all predicted impacts. In addition, the consequences and risks provided here assume no mitigation of the accident and take no credit for emergency response actions. The reduction in impacts due to these mitigation actions would be significant.

6.4.3.3 Disposal Facility Accidents

As discussed in Appendix F, disposal facility accidents were not evaluated because of the lack of details of ultimate disposal. However, except for dedicated centralized disposal facilities (e.g., Yucca Mountain and WIPP for HLW and TRUW, respectively), disposal sites would generally lack a concentrated volume of material at risk being stored in a configuration susceptible to phenomena such as fires and explosions

Table 6.4–20. LLMW Facility Accidents—Chemical-Related Health Risks From Maximum Reasonably Foreseeable Potential Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite Population Number of Cancer Incidences	Offsite MEI Probability of Cancer Incidence	WM Workers Number of Cancer Incidences	Offsite MEI Hazard Index	Maximally Exposed WM Worker IDLH[a] Index
			No Action				
INEL	Nonalpha, facility fire	>1E-02	*	1E-10	*	0.002	1
ORR	Nonalpha, facility fire	>1E-02	*	3E-07	*	4	2
SRS	Nonalpha, facility fire	>1E-02	*	3E-09	*	0.04	7
			Decentralized Alternative				
ANL-E	Nonalpha, facility fire	>1E-02	*	2E-11	*	0.0003	1
BNL	Nonalpha, facility fire	>1E-02	*	6E-10	*	0.01	1
FEMP	Nonalpha, facility fire	>1E-02	*	1E-08	*	0.2	2
Hanford	Nonalpha, facility fire	>1E-02	*	2E-09	*	0.03	5
INEL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	5
LANL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	3
LLNL	Nonalpha, facility fire	>1E-02	*	2E-08	*	0.4	3
NTS	Nonalpha, facility fire	>1E-02	*	7E-14	*	0.000001	1
ORR	Nonalpha, facility fire	>1E-02	*	6E-07	*	9	36
Pantex	Nonalpha, facility fire	>1E-02	*	5E-10	*	0.007	2
PGDP	Nonalpha, facility fire	>1E-02	*	2E-08	*	0.3	2
PORTS	Nonalpha, facility fire	>1E-02	*	8E-08	*	1	10
RFETS	Alpha, facility fire	>1E-02	*	1E-08	*	0.2	2
SNL-NM	Nonalpha, facility fire	>1E-02	*	1E-09	*	0.02	1
SRS	Nonalpha, facility fire	>1E-02	*	5E-09	*	0.09	14
			Regionalized Alternative 1				
FEMP	Nonalpha, facility fire	>1E-02	*	1E-08	*	0.2	2
Hanford	Nonalpha, facility fire	>1E-02	*	2E-09	*	0.03	5
INEL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	5
LANL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	3
LLNL	Nonalpha, facility fire	>1E-02	*	3E-08	*	0.4	3
ORR	Nonalpha, facility fire	>1E-02	*	6E-07	*	9	36
Pantex	Nonalpha, facility fire	>1E-02	*	5E-10	*	0.007	2
PGDP	Nonalpha, facility fire	>1E-02	*	2E-08	*	0.3	2
PORTS	Nonalpha, facility fire	>1E-02	*	8E-08	*	1	10
RFETS	Alpha, facility fire	>1E-02	*	1E-08	*	0.2	2
SRS	Nonalpha, facility fire	>1E-02	*	5E-09	*	0.09	14
			Regionalized Alternatives 2 & 3				
Hanford	Nonalpha, facility fire	>1E-02	*	3E-09	*	0.04	8
INEL	Alpha, facility fire	>1E-02	*	1E-08	*	0.2	6
LANL	Alpha, facility fire	>1E-02	*	8E-09	*	0.1	3
ORR	Nonalpha, facility fire	>1E-02	*	6E-07	*	9	36
PORTS	Nonalpha, facility fire	>1E-02	*	9E-08	*	2	11
RFETS	Alpha, facility fire	>1E-02	*	1E-08	*	0.2	2
SRS	Nonalpha, facility fire	>1E-02	*	5E-09	*	0.09	14
			Regionalized Alternative 4				
Hanford	Nonalpha, facility fire	>1E-02	*	3E-09	*	0.04	8
INEL	Alpha, facility fire	>1E-02	*	2E-08	*	0.3	9
ORR	Nonalpha, facility fire	>1E-02	*	7E-07	*	0.1	46
SRS	Nonalpha, facility fire	>1E-02	*	5E-09	*	0.09	14
			Centralized Alternative				
Hanford	Nonalpha, facility fire	>1E-02	*	3E-08	*	0.4	68

Notes: * = greater than 0 but less than 0.5. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] Immediately dangerous to life and health.

capable of causing significant releases. These repositories have accident analyses performed as part of their site-specific EISs. Although seismic events could breach in-ground containers, leading to airborne releases, such events would be bounded by accidents breaching the concentrated volumes of waste being held in a treatment or storage facility. The available safety literature does not indicate any credible accident sequence in which the risk from airborne releases in a low-level mixed waste disposal facility would be sufficiently significant to rule out a site from consideration and thereby serve as a discriminator among disposal alternatives.

6.5 Air Quality Impacts

The management of LLMW would not appreciably affect the air quality at most sites. However, centralization of treatment at the Hanford site could cause adverse air quality impacts requiring special emission control measures for criteria air pollutants. Emissions at RFETS could result in adverse air quality impacts if the waste at this site is treated or disposed of onsite. Emissions of hazardous air pollutants, including radionuclides, were estimated to be below the applicable standards at any site.

As illustrated in Table 6.5–1, DOE evaluated air quality impacts at each proposed LLMW treatment and disposal site based on estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (which include radionuclides), and toxic air pollutants. Pollutant emission estimates were made for the construction, and operations and maintenance (O&M) activities of LLMW facilities.

The Clean Air Act (42 USC 7401 *et seq.*) regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new sources of emissions from both "stationary" (e.g., treatment and storage facilities) and mobile (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for each criteria air pollutant for nonattainment areas. An entity which seeks to engage in an activity that will result in emissions equal to or greater than those limits in a nonattainment area must first obtain a permit.

In "attainment areas" (where air pollution standards are met), only new sources of emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit

Table 6.5–1. Air Quality Impacts Evaluated for LLMW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Table 6.5–2
	Operations	Estimated for thermal treatment units, for fuel use by all other LLMW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Table 6.5–3
Radionuclide emissions	Operations	For all LLMW treatment and disposal facilities	Percent of standard	Text discussion only
Hazardous and toxic air pollutant emissions	Operations	For all LLMW treatment and disposal facilities	Percent of standard	Text discussion only

is required for a new stationary source that equals or exceeds the allowable increase. However, a permit is not required for criteria pollutant emissions from mobile sources.

Subsequent to December 6, 1995, hazardous waste and LLMW facilities are subject to the requirements of the Resource Conservation Recovery Act regulations found at 40 CFR Part 264, subpart AA regarding air emission standards from process vents and subpart BB regarding air emission standards for process leaks. Compliance with the requirements of 40 CFR Part 264, subpart CC, regarding air emissions of volatile organic compounds from tanks, surface impoundments, and containers began June 6, 1996 (60 FR 56952).

6.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site. Both are considered to be "mobile sources."

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities

> ***Major Types of Air Pollutants***
>
> ***Criteria Air Pollutants:*** *carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*
>
> ***Hazardous Air Pollutants:*** *189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*
>
> ***Toxic Air Pollutants:*** *Other toxic compounds regulated by EPA and state or local governments*

under all the LLMW alternatives would result in emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. Table 6.5–2 lists those sites. DOE chose the 10% threshold to highlight those sites where criteria air pollutant emissions could result in adverse air quality impacts.

As indicated in Table 6.5–2, five of the 16 major proposed LLMW sites are located in nonattainment areas and, as a result of LLMW construction activities, would have emissions that equal or exceed 10% of the allowable limit for a particular criteria air pollutant. All five sites would exceed the 10% threshold in the Decentralized Alternative. Under the Regionalized 2, Regionalized 3, Regionalized 4, and Centralized Alternatives, ANL-E, NTS, and RFETS would exceed the 10% threshold.

DOE estimates that emissions from construction activities at RFETS could exceed the allowable level; thus, RFETS needs to obtain a Clean Air Act permit. In addition, construction activities at NTS would result in emissions at approximately 94% of the allowable limit for carbon monoxide. This percentage may overestimate potential impacts because it assumes that NTS is in a nonattainment region since it is adjacent to the Clark County nonattainment region for CO and PM_{10}. The NTS EIS (DOE, 1996b) does not show any exceedances for criteria pollutants.

6.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants are also emitted during operations and maintenance of LLMW facilities (stationary sources) and by vehicles that are driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

Eight of the 16 major proposed LLMW sites would equal or exceed 10% of applicable air pollutant emission standards (Table 6.5–3). Of these, two sites are located in nonattainment areas; six sites are in attainment areas. As many as seven sites would have pollutant standards that equal or exceed 10% of the levels under an alternative. Only the Hanford Site is estimated to exceed the standard: particulates would be approximately 50% above the standard in the Centralized Alternative, primarily from thermal destruction

Table 6.5–2. Percent of Sites' Allowable Air Emissions Discharged During Construction—LLMW Sites Equaling or Exceeding 10% of Standard in Nonattainment Regions[a]

Alternative	Number of Sites		Criteria Pollutants—Construction[b]					
			ANL-E	BNL	FEMP		NTS	
	T	D	NO_2	NO_2	VOC	NO_2	CO	PM_{10}
No Action[c]	3	NA	10 (9/1)			22 (20/2)	25(18/7)	
Decentralized	37	16	44 (39/5)	14 (5/9)	11 (3/8)	22 (16/6)	94 (64/30)	13(13/0)
Regionalized 1	11	12	27 (20/7)		16 (4/12)	30 (20/10)	26 (12/14)	
Regionalized 2	7	6	27 (20/7)				25 (12/13)	
Regionalized 3	7	1	27 (20/7)				73 (41/32)	
Regionalized 4	4	6	27 (20/7)				25(12/13)	
Centralized	1	1	27 (20/7)				25 (12/13)	

Alternative	Number of Sites		Criteria Pollutants—Construction[b]		
			RFETS		
	T	D	CO	NO_2	VOC
No Action	3	NA	95 (31/64)	94 (81/13)	31 (16/15)
Decentralized	37	16	169 (33/136)	114 (87/27)	50 (17/33)
Regionalized 1	11	12	169 (33/136)	114 (87/27)	50 (17/33)
Regionalized 2	7	6	107 (5/102)	32 (12/20)	27 (2/25)
Regionalized 3	7	1	107 (5/102)	32 (12/20)	27 (2/25)
Regionalized 4	4	6	48 (3/45)	16 (7/9)	12 (1/11)
Centralized	1	1	48 (3/45)	16 (7/9)	12 (1/11)

Notes: T = treatment; D = disposal; NA = not applicable; blanks indicate that a site does not exceed 10% of the standard under the specified alternative.
[a] Pollutants: CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter less than or equal to 10 micrometers in diameter; NO_2 = nitrogen dioxide; VOC = volatile organic compounds.
[b] Sites which exceed 10% of the limit specified by the General Conformity Rule; total % of limit (% equipment/% worker vehicles).
[c] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

Table 6.5–3. Percent of Sites' Allowable Air Emissions Discharged During Operations—LLMW Sites Equaling or Exceeding 10% of Standard[a]

Alternative	Number of Sites		Criteria Pollutants—Operation and Maintenance PSD or General Conformity						
			FEMP	Hanford		INEL		NTS	
	T	D	PM_{10}[c]	NO_2[c]	PM_{10}[c]	NO_2[c]	PM_{10}[c]	CO[d]	PM_{10}[d]
No Action[e]	3	NA				10			
Decentralized	37	16		12	22	15	13	21 (1/20)	10 (10/0)
Regionalized 1	11	12	12	13	23	15	13		
Regionalized 2	7	6		14	25		14		
Regionalized 3	7	1		14	25		14	39 (0/39)	
Regionalized 4	4	6		14	25	25	45		
Centralized	1	1		82	147				

Alternative	Number of Sites		Criteria Pollutants—Operation and Maintenance PSD or General Conformity								
			ORR		PORTS		RFETS			SRS	
	T	D	NO_2[c]	PM_{10}[c]	NO_2[c]	PM_{10}[c]	CO[d]	NO_2[b]	VOC[b]	NO_2[c]	PM_{10}[c]
No Action	3	NA	19	26			23 (1/22)			13	10
Decentralized	37	16	33	50		13	81 (1/80)	25 (9/16)	20 (1/19)		10
Regionalized 1	11	12	33	50	11	15	81 (1/80)	25 (9/16)	20 (1/19)		10
Regionalized 2	7	6	33	50	13	25	53 (1/52)	17 (6/11)	13 (0/13)		10
Regionalized 3	7	1	26	46	13	25	53 (1/52)	17 (6/11)	13 (0/13)		
Regionalized 4	4	6	51	77			24 (0/24)				10
Centralized	1	1					24 (0/24)				

Notes: T = treatment; D = disposal; NA = not applicable; blanks indicate that a site does not exceed 10% of the standard under the specified alternative.

[a] Pollutants: CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter equal to or less than 10 micrometers in diameter; NO_2 = nitrogen dioxide; VOC = volatile organic compounds.

[b] Nonattainment area for the pollutant ozone. NO_2 and VOC are ozone precursor pollutants; total % (% stationary-source/% mobile-source).

[c] Attainment area for this pollutant. PSD regulations applied; total % represents stationary source emissions only.

[d] Nonattainment area for this pollutant. General Conformity regulations applied; total % (% stationary-source/% mobile-source).

[e] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

emissions. Therefore, additional control measures may be needed at this site to reduce emissions of particulates to acceptable levels.

The most stringent PSD requirements are for Class I areas (40 CFR 52.21). Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 kilometers (62 miles) of a PSD Class I area. Nine sites proposed for LLMW activities under the alternatives are located within 100 kilometers of a PSD area: BNL, FEMP, INEL, LANL, LLNL, NTS, ORR, RFETS, and SNL-NM. None of these would have sufficient quantities of emissions to affect a PSD Class I area.

Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). No site was estimated to equal or exceed 10% of the standards.

6.5.3 Hazardous and Toxic Air Pollutant Emissions

Thermal treatment of LLMW will result in emission of small quantities of hazardous and toxic air pollutants. Hazardous air pollutants, other than radionuclides, and toxic air pollutants were evaluated by comparing estimated ambient concentrations to EPA guidelines and State Ambient Allowable Limits (AALs). Radionuclides from air emissions were evaluated by comparing the annual radiation dose to the MEI to the National Emissions Standard for Hazardous Air Pollutants (NESHAP)—10 millirem per year (40 CFR 61).

Doses from airborne radionuclides were estimated not to equal or exceed 10% of the dose standard at any site. In addition, nonradiological hazardous or toxic air pollutant concentrations at the treatment sites were estimated to be below 10% of the applicable guidelines or standards.

6.6 Water Resources Impacts

Impacts to water availability tend to decrease as the LLMW management facilities are Centralized. Major impacts to water availability from increased water use at the sites are unlikely, although there is the potential for adverse impacts at LLNL–Site 300. Modeling indicates that groundwater concentration reduction measures may be needed for radionuclides when disposal occurs at FEMP, the Hanford Site, ORR, SNL-NM, and SRS. Concentration reduction measures for radionuclides would not be needed when disposal occurs at NTS, even under the Regionalized 3 (one disposal site) Alternative.

As illustrated in Table 6.6–1, DOE analyzed the impacts on water resources of treatment and disposal activities. DOE evaluated the effects on water availability from building and operating treatment, storage and disposal facilities. DOE examined the effects of migration of radionuclides and chemicals from disposal facilities on groundwater quality.

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation

Table 6.6–1. Water Resources Impacts Evaluated for LLMW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Table 6.6–2
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used: • by personnel • by treatment and disposal processes	Percent increase in current water use	Table 6.6–2
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only
Groundwater quality	Post-closure	Disposal of LLMW	Percent of drinking water quality standard	Table 6.6–3

- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

6.6.1 WATER AVAILABILITY

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of LLMW facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite stream at a given site.

Table 6.6-2 identifies sites where projected water usage under any alternative would increase by more than 1%. This 1% threshold is based on the assumption that lesser changes are not likely to have significant impacts.

Table 6.6-2. Maximum Percent of Current Water Use for Construction or Operations—LLMW Sites Predicted to Exceed 1%

Alternative	Number of Sites		FEMP	INEL	LANL	LLNL	NTS	RFETS	SRS	WVDP
	T	D								
No Action[a]	3	NA	4.4	1.3	1.7	81	1.3	28	4.7	
Decentralized	37	16	4.4	1.9		20	3.9	33	2.2	2.8
Regionalized 1	11	12	5.9	1.9		22		33	2.2	
Regionalized 2	7	6				1.5		7.6	2.2	
Regionalized 3	7	1				1.5	2.4	7.6		
Regionalized 4	4	6				1.5		2.7	2.2	
Centralized	1	1				1.5		2.7		

Notes: T = treatment; D = disposal; NA = not applicable; blank cells are less than or equal to 1%. Water sources assumed as follows: Groundwater for FEMP, INEL, LANL, LLNL, NTS, and SRS; municipal water for RFETS; surface water for WVDP.
[a] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

Eight of the 16 major sites are predicted to exceed the 1% threshold. Most exceedances shown are due largely to water used during the 2–3 year period for construction of treatment facilities; however, under the No Action Alternative, large quantities of water for concrete would be needed to build storage facilities. Although projected water requirements exceed current water use by 1% or more at FEMP, INEL, LANL, NTS, SRS, and WVDP, these six sites are not likely to experience adverse impacts because of sufficient capacities and the relatively small amount of additional water needed (DOE, 1995a). Adverse impacts could be experienced at two sites, LLNL and RFETS, which are discussed further below.

Water use at LLNL would exceed 1% of current use for all alternatives and approach 81% under the No Action Alternative. This is based on the conservative assumption that water at Site 300, the assumed location for proposed WM facilities at LLNL, would be supplied by groundwater. However, most of the water would probably be supplied by a new municipal hookup for Site 300, or the Livermore Valley municipal system that serves LLNL. If the water were supplied by the new 500,000-gallons-per-day municipal hookup at Site 300, the maximum water use would be 14% of the capacity of the system. If the water were supplied by the municipal system in Livermore Valley, it would be less than 10% of the current water use rate of 717,000 gallons per day. If water for LLNL is supplied by an offsite municipal system, onsite water resources would not be affected. Therefore, adverse impacts to onsite water resources, though possible, are unlikely. Impacts on the source of the municipal supply are not within the scope of this PEIS.

Water use at RFETS would exceed 1% of current use for all alternatives. RFETS does not withdraw water from any onsite surface water or groundwater body. Instead, water is supplied by Denver Water from the South Boulder Creek and Ralston Reservoir via the South Boulder Diversion Canal. Under the Decentralized and Regionalized 1 Alternatives, construction of treatment and disposal facilities would require an additional 9.4% of the 1,000,000 gallon-per-day capacity of the water supply distribution system. The increases in water use result from adding new alpha LLMW treatment and disposal facilities. However, because water for RFETS is supplied by an offsite municipal system, onsite water resources would not be affected. Impacts on the source of the municipal supply are not within the scope of this PEIS, but would be expected to be very small, since the maximum usage for WM activities would be less than 0.05% of the 178.8 mgd of water supplied by Denver Water (Denver Water, 1996) to its customers in 1995.

As shown in the Volume II tables, for DOE sites that withdraw water directly from a surface water source (Hanford, ORR, PGDP, and WVDP), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (ANL-E, BNL, FEMP, ORR, Paducah, Portsmouth, RFETS, SRS, and WVDP), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

6.6.2 WATER QUALITY

DOE evaluated the impacts to groundwater quality caused by the migration of radionuclides and chemicals that leach from disposal facilities over time. DOE calculated concentrations of radionuclides and hazardous components at a hypothetical well located 300 meters from the center of the disposal facility, and compared these to EPA's drinking water standards (which have been adopted in DOE's internal orders). For radionuclides, the allowable drinking water concentrations equate to a 4 millirem-per-year effective dose equivalent.

The drinking water standards are used as comparison criteria for groundwater quality. Although they are not enforceable standards, they are often used as goals for contaminated site cleanup actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC 9601 *et seq.*). Because EPA established the drinking water standards to protect human health, groundwater concentrations of radionuclides and chemicals at or below these levels present a low risk.

Concentrations in the groundwater that equal or exceed 25% of the drinking water standard are presented, although the discussion of impacts concentrates on contaminants that are near or exceed drinking water standards. (See Appendix C for discussion on the methodology used in this analysis.)

6.6.2.1 Radionuclides

Table 6.6–3 and Table 6.6–4 identify sites where CH- and RH-LLMW would be disposed and where, under any alternative, the calculated value for any pollutant would exceed 25% of the drinking water standards for radionuclides.

Table 6.6–3. Percent of Drinking Water Standards for Radionuclides in Groundwater From Disposal of CH LLMW—Sites Exceeding 25% of Standard [a]

	Number of Sites		FEMP	Hanford			ORR			SNL-NM	SRS
Alternative	T	D	U-238	Tc-99	U-234	U-238	Pu-239	Pu-240	Tc-99	Pu-240	U-238
No Action	3	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	100*			100*	50	30	40	100*	100*
Regionalized 1	11	12	100*			100*	40		30	--	100*
Regionalized 2	7	6	--			100*	40	30	100*	--	100*
Regionalized 3	7	1	--	--	--	--	--	--	--	--	--
Regionalized 4	4	6	--			100*	50	30	100*	--	100*
Centralized	1	1	--	40	40	100*	--	--	--	--	--

Notes: T = treatment; D= disposal; -- = no disposal at this site under this alternative; * = WM PEIS modeling indicates that a reduction in the estimated concentration in the groundwater would be necessary to meet drinking water standards. See Volume II tables for the value of the exceedance. Blanks indicate that a site does not exceed 25% of the standard under the specified alternative.
[a] Only radionuclides equal to or above 25% of drinking water standards are listed. Blanks indicate concentrations less than 25% of standards. See Appendix C for a list of the drinking water standards.

Table 6.6–4. Percent of Drinking Water Standards for Radionuclides in Groundwater From Disposal of RH LLMW—Sites Exceeding 25% of Standard [a]

	Number of Sites		ORR				
Alternative	T	D [b]	Np-237	Pu-239	Pu-240	Tc-99	U-238
No Action	3	--	--	--	--	--	--
Decentralized	37	16	30	100*	100*	100*	100
Regionalized 1	11	12	30	100*	100*	100*	100
Regionalized 2	7	6	30	100*	100*	100*	100
Regionalized 3	7	1	30	100*	100*	100*	100
Regionalized 4	4	6	30	100*	100*	100*	100
Centralized	1	1	30	100*	100*	100*	100

Notes: T = treatment; D = disposal; -- = no disposal at this site under this alternative; * = WM PEIS modeling indicates that a reduction in the estimated concentration in the groundwater would be necessary to meet drinking water standards. See Volume II tables for the value of the exceedance.
[a] Only radionuclides equal to or above 25% of drinking water standards are listed. See Appendix C for a list of the drinking water standards.
[b] Number of disposal sites includes those disposing of CH-LLMW; disposal of RH-LLMW occurs at four sites (Hanford, INEL, ORR, and SRS) for all alternatives (except No Action, for which there is no disposal).

Disposal of CH-LLMW at FEMP, Hanford, ORR, SNL-NM, and SRS is predicted to cause 25% of drinking water standards for radionuclides to be exceeded in the groundwater. Of these sites, only FEMP is located above an EPA-designated sole-source aquifer. Twenty-five percent of standards would not be exceeded when CH-LLMW is disposed at ANL-E, BNL, INEL, LANL, LLNL, NTS, the Pantex Plant, Paducah, Portsmouth, or RFETS. A maximum of five sites would exceed 25% of drinking water standards under the Decentralized Alternative. Only under the Regionalized 3 Alternative (disposal of all CH-LLMW at NTS) are 25% of drinking water standards not exceeded.

Radionuclides that would exceed 25% of the drinking water standards are plutonium-239, plutonium-240, technetium-99, uranium-234, and uranium-238. These are all long half-life radionuclides, with the minimum half-life being 6,537 years for plutonium-240. Shorter half-life radionuclides (e.g., cesium-137, strontium-90) tend to decay to acceptable levels before reaching the 300-meter well.

For radionuclides with long half-lives, disposal inventory, infiltration rate, depth to groundwater, and the character of the media through which the water flows, are some of the primary factors that determine the concentration in the groundwater. The infiltration rate is related to rainfall, such that sites in arid regions generally perform better than sites in humid regions because of their smaller infiltration rate. Sites with a large depth to groundwater are generally better due to longer travel times. Sites located over areas with large percentages of materials that retard the movement of radionuclides (e.g., clays and organic materials) generally perform better than sites located over areas devoid of these materials.

For CH-LLMW, uranium-238 is the most problematic radionuclide, exceeding 100% of the standard at three sites (FEMP, the Hanford site, and SRS). In all of these cases, concentrations in the groundwater would have to be reduced to meet drinking water standards. Technetium-99 (ORR) and plutonium-240 (SNL-NM) would also have to be reduced to meet drinking water standards.

More recent estimates for the release of radionuclides to the groundwater based on updated waste loads project increases in the expected groundwater exceedances for particular radionuclides at these sites: FEMP (U-238), Hanford (U-238), SRS (U-238), and SNL-NM (Pu-240). See Appendix I of the Final WM PEIS.

Disposal of RH-LLMW at ORR is predicted to cause 25% of the drinking water standards to be exceeded for neptunium-237, plutonium-239, plutonium-240, technetium-99 and uranium-238. Drinking water standards would be exceeded for all alternatives except No Action, when all LLMW would be stored.

Concentrations of plutonium-239, plutonium-240, and technetium-99 would have to be reduced to meet drinking water standards. Disposal of RH-LLMW at Hanford, INEL, or SRS would not exceed 25% of standards.

Measures that could be used to reduce the estimated concentration of radionuclides in the groundwater include:

- Modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase adsorption or a concrete cap to reduce infiltration)
- Modifying the form of the waste to be disposed to reduce the release rate (e.g., changing to a vitrified waste form)
- Changing the specific location of the disposal facility so it is sited over an area with more favorable hydrologic conditions
- Imposing waste acceptance criteria (i.e., restricting the amount of the radionuclide allowed in the disposal facility)

The performance of disposal facilities at a specific site would be evaluated in greater detail in DOE's Performance Assessment process under DOE Order 5820.2A (DOE, 1988). This process would help to ensure that all regulatory requirements are met and significant contamination of groundwater would not occur.

6.6.2.2 Hazardous Constituents

The concentrations of hazardous constituents in the groundwater from disposal of LLMW are largely due to assumptions on the routing of wastes through the treatment system. As shown in the LLMW flow diagram (Figure 6.2–1), some wastes containing solvents were assumed to bypass the thermal treatment processes. The solvents in these wastes were not destroyed, but instead, ended up in the disposal facility. Some of these wastes contain solvents in large enough concentrations to cause standards to be exceeded when the wastes are disposed. In practice, LLMW to be disposed would meet EPA standards for treatment and disposal, and therefore should not produce major impacts to groundwater quality. Therefore, although the absolute values of the results for hazardous constituent contamination in groundwater are higher than would result from wastes treated to EPA standards, the results are still useful in showing the relative suitability of the sites. Even with the conservative assumptions used in the WM PEIS, drinking water standards were not exceeded at some sites. This may indicate that these sites are better for LLMW disposal than other sites.

As shown in Table 6.6–5, the WM PEIS analysis indicates that disposal of CH-LLMW at ANL-E, the Hanford Site, LANL, NTS, ORR, Portsmouth, RFETS, and SRS would cause 25% of drinking water standards for hazardous constituents to be exceeded in the groundwater.

A maximum of 8 sites would exceed 25% of drinking water standards under the Decentralized Alternative. Disposal of CH-LLMW at BNL, FEMP, INEL, LLNL, Paducah, Pantex, and SNL-NM would not exceed 25% of drinking water standards for hazardous constituents. Therefore, disposal at these latter sites is likely to pose less risk of groundwater contamination.

Hazardous constituents that exceed 25% of drinking water standards in the WM PEIS analysis include benzene, carbon tetrachloride, chromium, 1,2-dichloroethane, methylene chloride, selenium, and silver. Only chromium, selenium, and silver would not require reduction of concentrations to meet standards. Of these constituents, the solvents appear to be the most problematic, with methylene chloride requiring reductions at seven sites and with 1,2-dichloroethane requiring reductions at six sites.

Measures that could be used to reduce the concentration of hazardous constituents in the groundwater include those described for radionuclides. In addition, more rigorous treatment could be used to provide a greater removal/destruction efficiency than that assumed in the WM PEIS analysis.

Disposal of RH-LLMW at the Hanford Site, INEL, ORR, and SRS would not exceed 25% of drinking water standards. Reductions of groundwater concentrations of hazardous constituents would not be required for disposal of RH-LLMW.

As illustrated by Table 6.7–1, DOE analyzed the effects of construction site clearing to build LLMW treatment and disposal facilities, and the operation of treatment facilities on ecological resources at representative sites. DOE also considered the effects of accidental spills of LLMW in transportation, extrapolating the results from an assessment conducted for LLW.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for

Table 6.6-5. Percent of Drinking Water Standards for Hazardous Constituents in Groundwater From Disposal of CH LLMW— Sites Exceeding 25% of Standard [a]

Alternative	Number of Sites		ANL-E	Hanford					LANL		NTS[b]		
	T	D	B	B	CT	DCA	MC	Ag	DCA	MC	B	DCA	MC
No Action	3	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	30	100*	60	80	90		50	100*	50		40
Regionalized 1	11	12	--	100*	60	70	90		50	100*			40
Regionalized 2	7	6	--	100*	60	80	90	30	30	70			
Regionalized 3	7	1	--	--	--	--	--	--	--	--	100*	100*	100*
Regionalized 4	4	6	--	100*	70	80	100	30	--	--			
Centralized	1	1	--	100*	100*	100*	100*	40	--	--	--	--	--

Alternative	Number of Sites		ORR			PORTS		
	T	D	B	DCA	MC	B	DCA	MC
No Action	3	--	--	--	--	--	--	--
Decentralized	37	16	50	100*	100*		80	100*
Regionalized 1	11	12	50	100*	100*	30	100*	100*
Regionalized 2	7	6	70	100*	100*	--	--	--
Regionalized 3	7	1	--	--	--	--	--	--
Regionalized 4	4	6	70	100*	100*	--	--	--
Centralized	1	1	--	--	--	--	--	--

Alternative	Number of Sites		RFETS			SRS					
	T	D	CT	DCA	MC	B	Cr	CT	DCA	MC	Se
No Action	3	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	100*	100*	100*	100*	40	100*	100*	100*	30
Regionalized 1	11	12	100*	100*	100*	100*	40	100*	100*	100*	30
Regionalized 2	7	6	--	--	--	100*	40	100*	100*	100*	30
Regionalized 3	7	1	--	--	--	--	--	--	--	--	--
Regionalized 4	4	6	--	--	--	100*	40	100*	100*	100*	30
Centralized	1	1	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; -- = no disposal at this site under this alternative; * = WM PEIS modeling indicates that a reduction in the estimated concentration in the groundwater would be necessary to meet drinking water standards. See Volume II tables for the value of the exceedance. Blanks indicate that a site does not exceed 25% of the standard under the specified alternative.

[a] Only hazardous constituents equal to or above 25% of drinking water standards are listed. See Appendix C for a list of the drinking water standards. Blanks indicate concentrations less than 25% of the standards. Ag = silver; B = benzene; Cr = chromium; CT = carbon tetrachloride; DCA = 1,2-dichloroethane; MC = methylene chloride; Se = selenium.

[b] Note that the NTS EIS (DOE, 1996b) shows no exceedances of groundwater quality comparison criteria from disposal. The values presented here for NTS overestimate potential risks at that site since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over two million years (Sully et al., 1995).

6.7 Ecological Resources Impacts

Loss of limited acreages of habitat at some sites during construction of LLMW facilities would not significantly affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. DOE should be able to locate new LLMW facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction site acreages are small compared to the total acreage at each site suitable for waste operations. A screening level risk assessment of facility airborne emissions indicated that terrestrial wildlife species are not likely to be affected. Transportation accidents leading to spills of LLMW into aquatic environments would have serious short and long term consequences; however, the probability of such accidents is low but would increase with increased waste shipping.

Table 6.7-1. Ecological Resources Impacts Analyzed for LLMW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at LLMW construction sites to general habitat range	Text discussion only
Terrestrial species exposures	Terrestrial animal species	Comparison of estimated radiation dose of representative species with toxicity standard	Text discussion only
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats based on comparing construction acreage to available acreage of nonsensitive habitats	Text discussion only
Sensitive species concerns	Federally and State-listed endangered and threatened species	Numbers of Federally and State-listed species displayed by site/alternative	Table 6.7-2
Effects of transportation accidents	Aquatic species in streams crossing transportation corridors	Results of scenario-based modeling analysis of accidental spill; effects on fish in various size streams	Text discussion only

facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

6.7.1 General Impacts of Site Clearing

None of the alternatives would require extensive site clearing for construction of LLMW facilities. No more than 55 acres would be disturbed at any site, for any alternative. These acreage requirements are small compared to the available habitat for nonsensitive species represented at the sites. Although site clearing would destroy individual plants and would kill or displace individual animals (particularly small mammals and songbirds with limited home ranges), no significant effects to populations of these species are expected from implementation of any proposed LLMW alternatives because nonsensitive species habitats are well established regionally.

6.7.2 Site Clearing Effects on Sensitive Habitats

For those sites that contain sensitive habitats, the degree to which these habitats may be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby LLMW construction activities depends on DOE's ability to avoid siting near those habitats. A measure of this ability is the percentage of available land required at a site for facility construction under any LLMW alternative. Available acreage was estimated from site development plans either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percentage of available acreage required for the LLMW facilities ranged from 0.0009% at NTS under the Regionalized 1, 2, and 4 and the Centralized Alternatives to 4.4% at FEMP under the Regionalized 1 Alternative. Considering these small fractions of land required for LLMW facilities, DOE would have a great degree of flexibility in its siting and can employ a range of mitigative measures, so that site clearing to implement any of the LLMW alternatives would not affect adjacent sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff of water and soil to surface waters from construction sites. However, proper construction practices would minimize these effects. Direct discharges to surface waters from the routine operation of treatment facilities would comply with applicable regulations and would be limited by the use of accepted engineering techniques. Therefore, the impacts to aquatic organisms are expected to be minimal.

6.7.3 Effects of LLMW Treatment Facility Emissions

DOE used atmospheric emissions and deposition modeling to estimate the toxicity to terrestrial animals from airborne emissions of radionuclides and hazardous chemicals from treatment facilities. This analysis used the same atmospheric emissions estimates as the human health risk assessment and provided estimates of radionuclides and hazardous chemicals deposited on surface soils.

For this analysis, DOE examined those sites with the highest anticipated emissions. Six radionuclides were evaluated: tritium, Ni-63, Cs-137, Pu-241, Th-234, and U-238. Potential toxicity to terrestrial wildlife was analyzed for selected sites for these radionuclides, which comprise 80% of the total activity expected to be emitted. The remaining activity was contributed by smaller emissions of a large number of radionuclides. The conservative assumptions used to characterize the scenario (e.g., accumulation of contaminants for 10-year period with no loss due to decay or transport) might compensate for limiting the analyses to 80% of the released activity.

The concentrations of these radionuclides were used in calculating Hazard Indexes for each selected site/alternative combination as composite ratios between the estimated species exposures to each of the contaminants and known, contaminant-specific toxic levels. A Hazard Index greater than one would indicate a potential for the combined exposures to adversely affect the health of terrestrial species. Nine hazardous chemicals were evaluated—arsenic, barium, cadmium, chromium VI, cyanide, lead, mercury, selenium, and silver. The resulting maximum estimated Hazard Index values for the radionuclides and for the chemicals were less than 0.01. Therefore, no impacts to terrestrial animal populations are expected from LLMW facility airborne emissions.

6.7.4 Consideration of Sensitive Species

For comparison of the LLMW management program's potential to affect sensitive species, Table 6.7–2 lists the numbers of Federally and State-listed endangered and threatened species occurring or potentially occurring at each LLMW site under each alternative. Site-specific analysis would be required for an assessment of sensitive species impacts. That analysis would take into account specific locations for the LLMW facilities in relation to the location of sensitive habitats and sensitive species at each site, including species listed by the U.S. Fish and Wildlife Service as endangered or threatened.

Table 6.7–2. Numbers of Federally Listed and State-Listed Endangered and Threatened Species Occurring or Potentially Occurring at the LLMW Sites by Alternative (Federal/State)

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	3	NA	2/5	2/6	2/10	3/11	2/2	2/4	6/5	2/2	1/11	9/12	5/8	1/9	2/2	1/8	8/8	1/8
Decentralized	37	16	2/5	2/6	2/10	3/11	2/2	2/4	6/5	2/2	1/11	9/12	5/8	1/9	2/2	1/8	8/8	1/8
Regionalized 1	11	12	--	--	2/10	3/11	2/2	2/4	6/5	2/2	1/11	9/12	5/8	1/9	2/2	--	8/8	--
Regionalized 2	7	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	1/9	2/2	--	8/8	--
Regionalized 3	7	1	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	1/9	2/2	--	8/8	--
Regionalized 4	4	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	--	--	--	8/8	--
Centralized	1	1	--	--	--	3/11	--	--	--	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; NA = not applicable; -- = no major actions are proposed for the site under the alternative.

6.7.5 EFFECTS OF LLMW TRANSPORTATION ACCIDENTS

DOE believes that the radiologic effects on aquatic resources from transportation accidents involving LLMW would be similar to those estimated for LLW (See Chapter 7, Section 7.7.5). However, because LLMW also contains hazardous chemical components, transportation accidents could result in greater adverse effects to aquatic resources depending upon the specific chemical constituents contained in the waste. The number of expected accidents is related to the total number of miles traveled during LLMW shipment. Thus, as fewer shipments of LLMW occur, as in the Decentralized Alternative, the number of accidents is expected to decrease. The greatest potential for such accidents is under the Centralized Alternative. The toxic effects on aquatic resources from hazardous constituents in LLMW may be severe immediately following a spill, depending upon the chemicals involved, but are unlikely to have long-term effects due to emergency spill response efforts.

6.8 Economic Impacts

Nationwide, the largest economic effects resulting from LLMW management would be for the Decentralized Alternative and generally decrease as the alternatives become more Centralized. The greatest benefit at any site occurs when LLMW is treated, stored and disposed of at that site. The greatest percentage increases in the number of jobs would occur at the Hanford Site and INEL. The national economy would not be affected by total project expenditures for the construction, operation, or transportation to LLMW facilities under any alternative (DOE, 1995a).

DOE estimated the effects of expenditures for LLMW management on the local and national economies (Table 6.8–1). Local economic effects were based on direct expenditures at each site for construction, operation and maintenance, and decontamination of treatment and disposal facilities. The socioeconomic region of influence (ROI), where local effects were evaluated, consists essentially of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data for the ROI counties. Local jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at a national level only.

Table 6.8–1. Economic Impacts Analyzed for LLMW Alternatives

Economic Impact Analyzed	Affected Aspect of the Economy	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures for LLMW management multiplied by regional employment multiplier at each LLMW site	Text discussion only
Increased regional incomes	Regional personal income	Proposed site expenditures for LLMW management multiplied by regional income multiplier at each site	Text discussion only
National economic effects	National employment and personal income	Proposed site expenditures at all LLMW sites and total transportation expenditures multiplied by national employment and income multipliers	Text discussion only

Local economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined to estimate total project effects at each site. For all alternatives, except No Action, construction was assumed to take 4 years of the 10-year construction period; the operations phase was assumed to take 15 years (a 10-year operations and maintenance period and a 5-year decontamination period undertaken after the conclusion of operations). Under the No Action Alternative, in place of distinct construction and operational phases, all costs were assumed to occur in a 20-year work off of all existing waste (plus 5 years for decontamination and decommissioning). Five years were added to the decontamination and decommissioning phase to account for the continued effects on employment and income after each project phase ended. Job and personal income increases are shown for each site in the Volume II site tables.

Across the LLMW alternatives, only the Hanford site, INEL, and Portsmouth regions would experience greater than a 1% change in the number of new direct, indirect, and induced jobs as a result of expenditures to implement the alternatives. The Hanford region would experience an increase in the number of direct, indirect, and induced jobs of 1.7% under the Centralized Alternative. Regionalized Alternative 4 would result in the greatest increase in the number of regional jobs at INEL which is 2%. In the Decentralized and Regionalized 1, 2 and 3 Alternatives, the INEL region would experience a change ranging from 1.4% to 1.6% in the number of jobs in its ROI. The Portsmouth region would experience an increase in the number of new jobs of about 1% in the Decentralized Alternative and Regionalized Alternatives 1, 2 and 3. No ROIs would experience a 1% or greater increase in personal income under any of the alternatives.

The sum of the new direct, indirect, and induced jobs from the combined weighted construction and O&M activities across site ROIs for all the alternatives ranges from approximately 3,840 (under the No Action Alternative) to 11,250 (under the Decentralized Alternative).

In addition to analyzing the impacts on the regional economy, a comparison of these impacts was made on the national economy. None of the LLMW alternatives would substantially affect the national economy. The total number of jobs generated in the national economy from combined weighted construction and operations phase activities ranges from 5,650 under the No Action Alternative, due to long-term storage requirements, to 16,500 jobs under the Decentralized Alternative. Although the number of jobs appears large in absolute terms, 16,500 jobs represent only 0.01% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. It is likely that any changes would represent a shift in the source of income from previous employment to employment in LLMW projects rather than a net change in national personal income.

6.9 Population Impacts

No major population increases are expected at any site under any alternative, and thus community characteristics and the provision of services would not be affected.

Potential population changes in the ROI at each LLMW site were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used to evaluate the likelihood that population changes would cause effects, such as changes in community size and diversity, and effects on the provision of necessary services.

No site would experience 1% or greater increases in the ROI population. Regions containing two sites—INEL under Regionalized Alternative 4 and the Hanford site under the Centralized Alternative—would experience an estimated population increase of more than one-half of 1%, which may marginally affect community characteristics and services.

6.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of LLMW indicated that minority and low-income populations at the LLMW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the LLMW alternatives.

Analysis of environmental justice impacts from management of LLMW was based on a review of the impacts reported in this chapter regarding the LLMW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the 16 major LLMW sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done and includes maps illustrating the distribution of minority and low-income populations residing within 50 miles of each LLMW site.

6.10.1 Results

The potential for adverse human health effects from exposures to radionuclide emissions from LLMW treatment facility operations is low for all LLMW management alternatives for all LLMW sites. Incident-free LLMW treatment facility operations were analyzed (see Section 6.4.1) in terms of risk to workers and the public. The analysis indicated that incident-free operations present no significant risk and do not constitute a reasonably foreseeable adverse impact to the population surrounding any site. No disproportionately high and adverse health effects would be expected for any particular segment of the population, minority populations and low-income populations included. The number of potential fatalities due to both radiological and nonradiological exposures to truck or rail transportation of LLMW is small. A more detailed analysis of environmental justice impacts would be presented in NEPA reviews that deal with site-specific activities.

6.10.1.1 Transportation

Because incident-free LLMW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income populations, no environmental justice impacts are expected. As Section 6.4.2 indicates, the estimated total cancer fatalities resulting from incident-free transportation are less than 0.5 under all LLMW alternatives. The expected number of cancer fatalities due to radiation exposure from transportation accident releases, taking into account both the consequences of such a release and the probability that such a release will occur, is less than 0.5 under all alternatives. The expected number of transportation accident fatalities from trauma is no higher than 1 under any LLMW alternative. Therefore, disproportionately high and adverse health effects to minority or low-income populations from LLMW transportation are not expected to occur.

6.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 6.10 did not indicate any adverse impacts to water resources, ecology, economics, populations, land use, infrastructure, or cultural resources. Air quality impacts are possible at three sites, but no disproportionately high and adverse impacts are expected for any segment of the population.

None of the alternatives would have an adverse impact on land use, ecology, or cultural resources because of the limited amount of previously undisturbed land which would be needed for use onsite (no offsite lands are involved) and the mitigation programs already in place. These programs include working closely under agreements with State Historical Preservation Officers and Tribal governments regarding preservation of historic and cultural resources. Consultations with Tribal governments have expanded the DOE's awareness of Tribal interests and values with respect to nature, religion, and the land, and are designed to avoid or relocate these resources if possible. If avoidance were not possible, data recovery (such as archiving artifacts) or other mitigation measures may be developed in consultation with affected Tribes and the respective State Historical Preservation Officer, as appropriate. Similarly, the DOE is aware of sensitive ecological resources, and avoids wetlands and endangered plant or animal species habitats. Disturbance of certain ecological resources (which are not federally listed as threatened or endangered) is possible, but not likely. The reasonably foreseen environmental impacts, if any, to land use, ecological resources, or cultural resources are expected to be small under any of the alternatives, and DOE expects no disproportionately high and adverse environmental impacts to minority and low-income populations at the LLMW sites.

6.11 Land Use Impacts

Only at FEMP, under the No Action, Decentralized, and Regionalized Alternative 1, did the land requirement for facility construction exceed the 1% threshold of the acreage designated or suitable for waste operations. Further evaluation indicates the land requirements at FEMP are not expected to impact current onsite or offsite land uses. Site development plans indicated no conflict between proposed treatment or disposal facilities and other plans for the LLMW sites.

DOE examined the impacts of the LLMW alternatives on land use by comparing the acreage required for new treatment and disposal facilities to the acreage either designated for waste operations or suitable for development (see Table 6.11–1). Suitable land is the total site acreage, minus the acreage required for known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts among the proposed facilities required under each alternative and plans for future site uses.

Under all alternatives, only the land requirements at FEMP exceeded the 1% threshold. In addition, proposed treatment or disposal facilities were not in conflict with the development plans for any site.

For FEMP, the 1% threshold was exceeded when facilities were built or expanded: the No Action Alternative would require 2.3% (6 acres) of the designated waste management area, the Decentralized Alternative would require 3.1% (9 acres), and Regionalized Alternative 1 would require 4.5% (12 acres). However, because only a small fraction of the 275 acres of designated waste operations land at FEMP is

Table 6.11–1. Land Use Impacts Analyzed for LLMW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each LLMW site	Land use shown in site development plans	Comparison of required acreage with amount designated (or estimated) for LLMW in site development plan—all instances where requirements are 1% or higher are noted	Text discussion only
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed LLMW uses and nearby land uses	Text discussion only

required under these alternatives, no significant onsite land use impacts are expected to occur. For the same reason, no conflicts with adjacent land uses are expected.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations within a site.

6.12 Infrastructure Impacts

Although no offsite infrastructure impacts are expected to occur, proposed LLMW activities would affect the onsite infrastructure at 14 sites. Nine sites experience increased requirements for water, wastewater treatment, or electrical power of 5% or greater of current system capacity. However, only the wastewater requirement at the Hanford Site (under the Centralized Alternative) is estimated to exceed the existing treatment capacity. Onsite transportation infrastructure would be affected at 12 sites because of site employment increases of 5% or more above current levels.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and power (see Table 6.12–1). Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater from construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on the community infrastructure.

Table 6.12–2 shows the increase in onsite demand for water, wastewater treatment, and power at sites where the increase exceeds 5%. The potential for a major impact is assumed to exist where an increase of 5% or greater causes total demand to exceed 90% of capacity. A moderate impact is assumed where total demand remains below 90% of capacity. Impacts to offsite infrastructure are not expected because population increases do not exceed 5% at any site under any alternative.

Table 6.12–1. Infrastructure Impacts Analyzed for LLMW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support LLMW facilities	Onsite water, power, and wastewater systems	Add increased LLMW facility use to current use—compare to current capacities	Table 6.12–2
	Onsite transportation infrastructure	Compare new site employment with current site employment as an index of increased stress	Table 6.12–3
Capacity of community infrastructure to support increased worker populations and their families	Regional water, power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion only

Table 6.12–2. Increase in Demand for Water, Wastewater Treatment, or Power as a Percent of Current Capacity—LLMW Sites With Increases Exceeding 5%

Alternative	Number of Sites		ANL-E	FEMP	Hanford	INEL	LANL	LLNL	NTS	RFETS	SRS
	T	D									
No Action[a]	3	NA	**P (19)**	P (8)		P (25)	P (8)	P (10)	P (9)	P (31) W (8)	P (6)
Decentralized	37	16		P (7)		P (13)			P (15) Ww (6)	P (33) W (9)	
Regionalized 1	11	12	--			P (13)				P (33) W (9)	
Regionalized 2	7	6	--	--	Ww (5)			--		P (5)	
Regionalized 3	7	1	--	--				--	P (8)	P (5)	
Regionalized 4	4	6	--	--	Ww (5)	P (6)		--			
Centralized	1	1	--	--	Ww (22)	--	--	--			--

Notes: T = treatment; D = disposal; NA = not applicable; W = water; Ww = wastewater; P = power; -- = no major actions are proposed for the site under the alternative. Bold indicates major impact, all others moderate. Blank cells indicate less than 5% of current capacities. Numbers in parentheses represent percentage increases.

[a] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW. Beyond 20 years, waste storage infrastructure requirements would be expected to be the same or greater; however, site infrastructure capacity changes could change the percentages in the table. See Section 6.16 for additional information on longer term impacts.

As shown in Table 6.12–2, most of the infrastructure impacts relate to demand for power. Major wastewater treatment impacts would occur only at the Hanford Site under the Centralized Alternative, increasing the current demand by 22%. A further evaluation found that this increase also could cause the current system capacity to be exceeded by 1%. If new construction were needed to increase system capacity, additional environmental impacts and costs would result.

Table 6.12–3 identifies sites at which the increase in site employment from construction activities exceeds 5%. These sites could experience impacts to the onsite transportation infrastructure from increased worker traffic (DOE, 1995a).

6.13 Cultural Resources Impacts

Construction of LLMW facilities could adversely affect cultural resources. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007) may be affected at sites where LLMW treatment and disposal facilities are proposed to be built. Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys at the 16 major proposed LLMW sites and lists the reported cultural resources at those sites. However, the impacts of the construction of LLMW facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site (DOE, 1995a).

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Table 6.12–3. Percent Increase in Site Employment From Construction—LLMW Sites With Employment Increases Equal to or Greater Than 5%

Alternative	Number of Sites		FEMP	Hanford	INEL	LANL	LLNL	ORR	Pantex	PGDP	PORTS	RFETS	SRS	WVDP
	T	D												
No Action[a]	3	--			5							7		5
Decentralized	37	16	13		7	6		5	5	11	20	14		
Regionalized 1	11	12	20		7	6	6	5	5	8	20	14		
Regionalized 2	7	6	--		6	8	--	5		--	19	11		
Regionalized 3	7	1	--		5	6	--			--	19	11		
Regionalized 4	4	6	--		9		--	6		--	5	5	5	
Centralized	1	1	--	14		--	--			--	5	5		

Notes: T = treatment; D = disposal; NA = not applicable; -- = no major actions are proposed at the site under the alternative. Blank cells indicate site employment increases of less than 5%.

[a] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW. Beyond 20 years, requirements to rehabilitate or replace aging facilities could result in equal or greater impacts from construction. See Section 6.16 for additional information on longer term impacts.

Land requirements for the construction of LLMW waste management facilities are sufficiently small under all alternatives so that DOE would probably have enough flexibility in siting LLMW facilities to avoid impacts on cultural resources. If not, measures would be taken to mitigate negative effects on these resources.

6.14 Costs Impacts

Costs decrease as the number of treatment and disposal sites decrease, ranging from $12.3 billion for the Decentralized Alternative to $7.7 billion for the Centralized Alternative. Transportation costs are much lower than facility costs, making shipment to available facilities at another site generally less expensive than building a new facility on site.

As indicated in Table 6.14–1, DOE estimated costs for building and operating treatment and disposal facilities, and for transportation (INEL, 1995a,b). DOE evaluated costs associated with LLMW management from both a life-cycle and process perspective, using 1994 dollars.

Table 6.14–1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts Are Assessed	Location of Impacts Assessment
Process Costs	Treatment	Life-cycle costs for treatment including support facilities	Table 6.14–2
	Storage[a]	Life-cycle costs for storage facilities	Table 6.14–2
	Disposal[b]	Life-cycle costs for disposal facilities	Table 6.14–2
Transportation Costs	Truck	Inter-site common carrier costs for transportation from generating sites to treating sites, and to disposal sites	Table 6.14–2
	Rail	See above	Table 6.14–2

[a] No Action Alternative includes 20 years of storage and limited operations and maintenance.
[b] Disposal includes closure and 300 years of post-closure custodial support.

6.14.1 Life-Cycle Costs

DOE evaluated facility costs for four phases representing the life cycle of the facilities and their operations: pre-operations, construction, operations and maintenance, and decontamination and decommissioning. Life-cycle costs do not include speculative factors, such as the impacts on long-term value of land.

Costs for pre-operation activities consist of technology and site adaptation, including bench-scale tests and demonstrations; permitting; plant startup and cold run costs; and related reference design, safety analysis, project management, and contingencies.

Facility construction costs consist of building construction, equipment purchase and installation, contractor overhead, and related design, construction management, project management, and contingencies. Mobilization and demobilization costs are included for portable treatment units.

Operations and maintenance costs consist of annual operations labor and material, maintenance labor and equipment, utilities, contractor supervision and overhead, and related project management and contingencies.

Decontamination and decommissioning costs consist of facility decontamination and demolition, closure, post-closure, and environmental monitoring activities.

6.14.2 Process Costs

DOE also analyzed costs based on treatment, storage, and disposal activities. Treatment costs include costs to build and operate treatment facilities (such as grout solidification or thermal destruction) and common support facilities (such as maintenance and certification/shipping facilities).

For the purpose of the WM PEIS analysis, LLMW storage capacity is assumed to be sufficient, except for the No Action Alternative. DOE estimated the costs to build and operate sufficient storage capacity to contain all LLMW managed in the No Action Alternative.

Disposal costs include costs to build and operate front-end administration and receiving facilities for disposal as well as the actual disposal units.

Transportation costs include the costs associated with the physical movement of the waste from one site to another, for either treatment or disposal. Transportation costs are evaluated for both truck transportation and rail shipments (INEL, 1995a).

The summary of costs is shown in Table 6.14–2 (INEL, 1996). Construction accounts for 27% to 32% of the total costs and O&M accounts for 56% to 55% of those costs. As waste is consolidated at fewer sites, costs for treatment and disposal facilities decrease, reflecting the economy of scale of using larger and fewer facilities. The difference between the Decentralized Alternative and Centralized Alternative is $4.6 billion—of which $3.0 billion (65%) would be for treatment.

Under the No Action Alternative, DOE would treat LLMW at existing or planned facilities, and would then store the waste for the period of analysis. Although the costs for this alternative are the lowest of any LLMW alternative, the No Action Alternative does not comply with RCRA. The No Action Alternative costs provide a baseline for comparison with the other alternatives that would be in compliance.

Table 6.14–2. Life-Cycle Costs
(Billions of 1994 Dollars)

Alternative	Number of Sites		Total Costs[a] (Including Truck Transportation)	Life-Cycle Costs				Process Costs			Transportation Costs	
	T	D		Pre-ops	Const	O&M	D&D	T	S[b]	D	Truck	Rail
No Action[c]	3	NA	5.2	0.4	1.4	2.7	0.7	2.5	2.7	0	0	0
Decentralized	37	16	12.3	1.4	3.9	6.1	0.9	9.8	0	2.5	0.001	0.0007
Regionalized 1	11	12	11.0	1.1	3.3	5.7	0.9	8.6	0	2.4	0.004	0.002
Regionalized 2	7	6	9.5	0.9	2.8	5.1	0.7	7.6	0	1.9	0.02	0.005
Regionalized 3	7	1	8.4	0.8	2.5	4.6	0.5	7.6	0	0.7	0.06	0.02
Regionalized 4	4	6	8.4	0.8	2.4	4.7	0.5	7.0	0	1.4	0.006	0.005
Centralized	1	1	7.7	0.7	2.2	4.3	0.5	6.8	0	0.9	0.03	0.01

Notes: T = treatment; S = storage; D = disposal; NA = not applicable; Pre-ops = preoperations; Const = construction; O&M = operations and maintenance; D&D = decontamination and decommissioning.

[a] Total Facility Costs are presented twice in this table: as life-cycle costs and as process costs. The sum of life-cycle costs is equal to the sum of process costs. Total Costs, also in the table, add truck costs to the facility costs. Therefore, Total Costs equals the sum of life-cycle costs and truck costs and also equals the sum of process costs and truck costs.

[b] RCRA-compliant storage facilities are constructed under the No Action Alternative; for the other alternatives, the existing onsite storage was assumed to be adequate since treatment or packaging for transportation to regional treatment sites would reduce the amount of waste currently being stored on the site. The cost of current storage is included in the site infrastructure accounts which are not included in this PEIS.

[c] Costs under the No Action Alternative include those from only the first 20 years of indefinite storage; see Section 6.16 for additional information on longer term impacts.

Although the quantity of waste requiring transport is at its maximum in the alternatives that centralize functions at NTS or the Hanford Site, the relative proportion of transportation costs remains small, less than approximately 0.7% of total costs.

6.15 Environmental-Restoration-Transferred Waste

The volume of LLMW generated by environmental restoration activities that would be transferred to the waste management program is currently estimated to be about 90% of the volume of waste management LLMW. Because the radiological profiles and physical characteristics of the environmental restoration (ER) transferred LLMW have not yet been determined to the extent necessary to allow a meaningful evaluation of the potential environmental and human health impacts, the ER transferred LLMW volumes are discussed separately in the WM PEIS. When the radiological profiles and physical characteristics of the ER transferred waste are better known, DOE may be required to assess the impacts of managing the ER transferred LLMW on a site-specific basis.

DOE is responsible for the management of wastes currently in inventory and those generated by future operations (referred to as "waste management" wastes). As discussed in Chapter 1, DOE is also responsible for the management and remediation of contaminated media, including soils, groundwater, and buildings. DOE expects that most of the contaminated media at its sites will be remediated under the Environmental Restoration Program. The extent to which media are "cleaned up" is site specific and will depend largely on regulatory requirements and decisions regarding future land use. For analyses purposes, a standard "base case" scenario has been developed that estimates remediation costs across the DOE complex (DOE 1996c). Although most waste generated by cleanup activities will be managed within the Environmental Restoration Program, a certain subset of the waste generated by these activities will be transferred to waste management facilities. In this PEIS, these wastes are referred to as "environmental restoration (ER) transferred wastes." At present, only estimates of the volumes of ER transferred waste are available. These estimates were used to provide a qualitative assessment about how the addition of ER transferred waste may affect LLMW alternatives.

Appendix B provides more detail on how certain wastes generated during environmental restoration will be transferred to the waste management program for final disposition, and provides estimates of the volumes of ER transferred LLMW. Appendix B also discusses the assumptions and uncertainties involved in assessing how ER transferred LLMW may affect waste management alternatives.

To conduct a health risk impact analysis for the additional ER transferred LLMW similar to that conducted for waste management LLMW, additional information is needed on the ER transferred waste streams. In addition to the volume of ER transferred waste, information is needed on the treatability of the individual transferred LLMW streams that would include data about the radiological profile, chemical constituents, and physical form of the ER transferred waste. The wastes would also have to be categorized according to alpha and non-alpha radionuclide composition. Physical characterization of the ER transferred wastes into one of the treatment categories identified for LLMW is needed to estimate management costs. Information about the timing for the transfer of ER wastes to the waste management program is needed to determine the capacities of treatment and disposal facilities. This information is also crucial to conduct transportation and socioeconomic analyses. However, in many cases, this information will not be available until site-specific cleanup is conducted.

To identify how the addition of ER transferred LLMW could affect the comparison among waste management alternatives in the WM PEIS, DOE compared the volumes of waste management LLMW with the expected volumes of ER transferred LLMW. This analysis reveals the potential for overloading treatment facilities for those sites and alternatives where the volumes of ER transferred LLMW are projected to equal or exceed the volumes of waste management LLMW. Strategies to manage the additional loading of ER transferred LLMW in order to avoid overloading facilities include increasing operational capacity and operating a facility longer to "work off" the increased waste load. The WM PEIS treatment facilities are assumed to have an operational life of at least 30 years, which allows for an additional 20 years of operational capacity beyond the 10 years needed to work off the waste management wastes.

Increased radiation and chemical exposure risks to site workers, offsite populations, and the environment are related to the chemical constituents and radiological activity in the ER transferred wastes which, at present, cannot be reliably predicted. However, because radiological activities and chemical concentrations in ER transferred waste are, in general, expected to be lower than those for comparable waste management waste, risks from the addition of ER transferred wastes are expected to be lower than the risks resulting from the treatment of equivalent volumes of waste management wastes. Site-specific performance assessments would be conducted and appropriate restrictions would be imposed to manage any potential increased risks. The risks from physical hazards associated with operating facilities to manage the ER transferred waste are related to the volume relationship between the ER transferred and waste management wastes. Transportation risks and costs are also dependent upon waste volumes rather than the composition of the waste.

Overall, the volume of ER transferred LLMW is expected to be about 90% of the waste management LLMW load (200,000 cubic meters compared with 219,000 cubic meters, respectively). See Table B.6-1. The additional ER transferred waste would affect waste treatment at two sites, RFETS and SRS under the Decentralized and Regionalized Alternatives (see Table B.7-2). The ER transferred LLMW load at RFETS is expected to be up to 200% of the waste management LLMW load while at SRS the ER transferred LLMW is expected to be 750% of the waste management LLMW. The additional ER transferred LLMW would have little effect on the Centralized Alternative.

6.16 Comparison of Alternatives Summary

The LLMW impacts were evaluated across all the LLMW alternatives to identify trends and ultimately the preferred alternative. Although some impact areas, including cost, illustrated clear trends across the alternatives, most did not. Rather, the analysis of the impacts illustrated sensitivities at particular sites, regardless of the alternative.

The following discussion focuses on each impact area, identifying alternative trends when appropriate, and highlighting noteworthy findings at particular sites.

Health Risks. Risks at sites treating or disposing of LLMW are principally to workers, rather than for other receptor groups, driven by physical injury hazards. As the number of sites decreases, facilities become larger and programwide physical injuries decrease, reflecting an economy of scale and fewer total workers.

The most important influence on offsite population risk is treatment of tritium in the Decentralized and Regionalized 1 Alternatives. There are no other notable trends for offsite population risks.

For disposal, concentrations of radionuclides and chemicals in the groundwater near disposal facilities could exceed applicable standards at several sites, demonstrating the need for performance-based waste acceptance criteria and other site-specific considerations. More extensive pretreatment of chemicals and management of radionuclide concentrations and waste forms could be required to assure acceptable water quality and human health risks. One of the most prevalent causes of the exceedances was unconstrained disposal of uranium-238 at the Hanford Site and SRS, which was evaluated under most of the alternatives. Disposal of LLMW containing this radionuclide must be carefully managed at these sites. Exceedances were also recorded for all disposal alternatives at FEMP (uranium-driven), SNL-NM (plutonium-driven), and ORR (disposal of contact-handled and remote-handled waste with high concentrations of uranium-238, technetium-99, and plutonium-239 and plutonium-240). Up to four chemicals could exceed standards at seven sites, demonstrating the need for more rigorous pretreatment and primary treatment to meet LDRs than was evaluated in the WM PEIS.

Intruder risks are generally higher at sites that combine high radioactivity and long-lived radionuclides. These risks decrease with time, with the lowest risks after 300 years experienced at three sites with new disposal facilities in the Decentralized Alternative (BNL, the Pantex Plant, and SNL-NM). Transportation risks are low in all alternatives, reflecting low vehicle miles.

Air Quality Impacts. The management of LLMW does not affect the air quality at most sites. However, centralization of treatment at Hanford could cause adverse air quality impacts requiring special emission control measures for criteria air pollutants. Emissions from equipment and vehicles during construction at RFETS could result in adverse air quality impacts if the waste at this site is managed onsite as proposed in the Decentralized and Regionalized 1, 2, and 3 Alternatives. Emissions of hazardous air pollutants, including radionuclides, were estimated to be below the applicable standards at any site.

Water Resources Impacts. Impacts to water availability tend to decrease as the LLMW management facilities are Centralized. Major impacts to water availability from increased water use at the sites are unlikely, although there is the potential for adverse impacts at LLNL–Site 300.

Impacts to water quality were discussed under health risks. Careful management of waste through performance-based acceptance criteria would be required, as well as careful selection of technology, to avoid exceedance of drinking water standards at a number of sites.

Ecological Resources, Cultural Resources, Environmental Justice Concerns, and Land Use. The WM PEIS did not provide discriminators among the alternatives in these four impact areas. The programmatic analysis that was conducted did not reveal any major impacts in any alternative. However, impacts to ecological and cultural resources are dependent to some degree on specific technologies and their location at each site. These were not determined at the programmatic level of the WM PEIS, and consequently these impact areas would be evaluated in more detail when such site-level details are evaluated. Assessment of potential environmental justice impacts indicated that minority and low-income populations at the LLMW sites would not experience disproportionately high and adverse impacts under any LLMW alternative. Land use is not a discriminator because the LLMW alternatives do not use much land compared to the amount available at every site.

Economic Impacts. Nationwide, the largest economic effects resulting from LLMW management would be for the Decentralized Alternative and generally decrease as the alternatives become more Centralized. The greatest benefit at any site occurs when LLMW is managed at that site. The greatest percentage increases in the number of jobs would occur at the Hanford Site in the Centralized Alternative and INEL in Regionalized Alternative 4. The national economy would not be affected by total project expenditures for the construction, operation, or transportation to LLMW facilities under any alternative.

Population Impacts. No major population increases are expected at any site under any alternative, and thus community characteristics and the provision of services would not be affected.

Infrastructure Impacts. Although no offsite infrastructure impacts are expected to occur, proposed LLMW activities would affect the onsite infrastructure at 14 sites. Nine sites experience increased requirements for water, wastewater treatment, or electrical power of 5% or greater of current system capacity. Greatest increases are at RFETS in the Decentralized and Regionalized Alternative 1, and the Hanford Site in the Centralized Alternative, when waste is consolidated for treatment and disposal at these sites. However, only the wastewater requirement at the Hanford Site (under the Centralized Alternative) is estimated to exceed the existing treatment capacity. Onsite transportation infrastructure would be affected at 12 sites because of site employment increases of 5% or more above current levels.

Costs. Costs decrease as the number of treatment and disposal sites decrease, ranging from $12.3 billion for the Decentralized Alternative to $7.7 billion for the Centralized Alternative. Transportation costs are much lower than facility costs, making shipment to available facilities at another site generally less expensive than building a new facility onsite. Actual cost differences have not been calculated for this document for the privatization or commercialization of DOE waste management activities. The reason for pursuing both privatization and commercialization is the belief that private vendors could be able to perform the same tasks faster and at a lower cost than DOE, through innovative technology, efficient oversight, and application of other streamlined business practices. In the experience of other institutions that have attempted privatization, savings are more common than increased costs. The details of cost estimating are covered in Section 5.3.3 of Chapter 5.

Summary of Impacts by Alternative. Tables 6.16–1 and 6.16–2 summarize key impacts for each alternative.

Long-Term (Beyond 20 Years) Effects of Indefinite Storage Under the No Action Alternative. The risks, environmental impacts, and costs identified in the WM PEIS from storage of LLMW under the No Action Alternative are based on a 20-year period of analysis. As shown in Tables 6.16–1 and 6.16–2, these impacts and costs are less than for the action alternatives in some impact categories. Impacts are expected beyond this 20-year time frame, however, not only as a result of routine indefinite storage operations, but also from degradation of facilities and containers. These impacts are likely to be greater than those for the first 20 years. This differs from the effects predicted for the action alternatives for management of the 20-year forecast of LLMW, where risks to workers and to the offsite population and other impacts and costs are greatly reduced following disposal. (Potential migration of contaminants into the environment and potential intrusions, which could result in long-term risks for all alternatives, are discussed further below.)

For the period beyond 20 years, risks and other impacts associated with monitoring and maintaining the LLMW storage facilities are likely to increase as waste containers and storage facilities deteriorate. Added to the 20-year risks presented in the No Action Alternative would be those to the public from increased package and facility emissions and to workers from increased inspections and corrective actions around degrading facilities. At some point beyond 20 years, increasing maintenance would require replacement of the facilities and repackaging of the waste. The risks and costs of such actions would be greater than for the earlier new construction and packaging because of the deteriorated condition of materials.

Over time, the potential for chronic leakage and accidents increases. The waste under the No Action Alternative is largely untreated waste, so it contains both hazardous chemicals and unstabilized radioactive waste. The corrosion of the containers may interact with these chemicals, leading to pressure buildup within the containers and a corresponding greater likelihood of leakage. Once released, the untreated wastes would pose a greater risk to human health than the treated, stabilized waste produced in the action alternatives.

Risks from emissions during routine operations or from accidents and leakage could be further increased for the offsite public if the population near storage sites continues to grow. The population density near sites

Table 6.16-1. Comparison of LLMW Alternatives—Projected Risk Results

Alternative	Number of Sites		Treatment Worker Physical Hazard Fatalities	Treatment Worker Cancer Fatalities	Offsite Population Cancer Fatalities	Disposal Worker Physical Hazard Fatalities	Disposal Worker Cancer Fatalities	Groundwater Impacts from Disposal			Truck Radiation Fatalities	Truck Non-Radiation Fatalities
	T	D						Number of Sites That Meet Groundwater Standards for Radionuclides Without Additional Constraints	Number of Sites That Require Additional Constraints to Meet Standards	Radionuclides[a] Which Must Be Constrained for Sites to Meet Standards		
No Action[b]	3	--	2	1	*	NA	NA	--	--	--	--	--
Decentralized	37	16	4	1	*	*	1	11	4	U-238, Pu-240	*	*
Regionalized 1	11	12	4	1	*	*	1	9	3	U-238	*	*
Regionalized 2	7	6	3	1	*	*	1	3	3	U-238, Tc-99	*	*
Regionalized 3	7	1	3	1	*	*	*	1	0	--	*	1
Regionalized 4	4	6	3	1	*	*	1	3	3	U-238, Tc-99	*	*
Centralized	1	1	3	1	*	*	*	0	1	U-238	*	1

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.5; -- = action not applicable for this alternative.

[a] Additional reductions to chemical concentrations may also be required to meet chemical groundwater standards at each site (see Section 6.6). This requires treatment options not evaluated in the WM PEIS. RH-LLMW, disposed of in every alternative except No Action at ORR, would also require additional constraints to assumed concentrations of Pu-239, Pu-240, and Tc-99 in order to meet groundwater standards.

[b] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

Table 6.16–2. Comparison of LLMW Alternatives—Selected Impacts

Alternative	Number of Sites		Number of Sites With Air Pollutants That Exceed Standards	Highest Air Pollutant Percentages at Any Site	Cost ($ Billions)	Truck Shipments	Comment
	T	D					
No Action[a]	3	NA	0	95 (CO-RFETS)	5.2	NA	Extended storage at every site—does not comply with RCRA
Decentralized	37	16	1	169(CO-RFETS)	12.3	500	Maximum number of sites treat and dispose
Regionalized 1	11	12	1	169(CO-RFETS)	11.0	1,800	LDRs treatment at 6 western, 5 eastern sites; disposal at 12
Regionalized 2	7	6	1	107(CO-RFETS)	9.5	5,600	LDRs treatment at 4 western, 3 eastern sites; disposal at current LLW disposal sites
Regionalized 3	7	1	1	107(CO-RFETS)	8.4	11,000	LDRs treatment at 4 western, 3 eastern sites; Centralized disposal at NTS
Regionalized 4	4	6	0	77(PM_{10}-ORR)	8.4	4,300	LDRs treatment and disposal at 2 western, 2 eastern large generators; disposal at current LLW disposal sites
Centralized	1	1	1	147 (PM_{10}-HS)	7.7	7,500	Centralized treatment and disposal at the Hanford site

Notes: T = treatment; D= disposal; NA = not applicable.
[a] The No Action Alternative includes impacts from only the first 20 years of indefinite storage of LLMW; see Section 6.16 for additional information on longer term impacts.

could be expected to increase over time, and the possibility of encroachment into current buffer areas would also increase.

Although it is DOE's intent to maintain control as long as necessary to assure public health and safety, at some date in the future, loss of institutional control of the storage facility must be assumed for a conservative analysis. With loss of control, the potential for intrusion into the facility and movement of contaminants into the environment sharply increases. The risks predicted for a human intruder into a storage facility containing untreated wastes are likely to be as high or higher than those presented in Section 6.4.1.10 for intrusion into a disposal facility. In particular, the presence of untreated chemicals in the stored wastes would increase the risk from chemical exposures. Migration of the waste into the groundwater from a storage facility, which could also be expected at some time after maintenance and control of the facility has ended, could pose risks as high or higher than those presented for the hypothetical farm family and population in Sections 6.4.1.8 and 6.4.1.9. The untreated condition of the waste could result in faster movement of contaminants through the groundwater, which could contain both a greater concentration of short-lived radionuclides and a higher concentration of chemicals. These conditions would add to the risks predicted for migration from a disposal facility.

Should the No Action Alternative be selected in the near term, it would be reasonable to expect a decision to treat and dispose of the waste at some point in the future, both because of the continued accumulation of effects already noted and because indefinite storage of untreated waste does not fulfill obligations under existing laws or agreements. Should such a decision be made, it is likely that the impacts and risks for treating and disposing would be greater than those shown for the action alternatives; the further deterioration of the waste containers over time would present a more difficult management situation. Consequently, for a course of action that continues storage of untreated LLMW for 20 years or more and then accomplishes treatment and disposal at some future date, the total impacts and costs would be likely to exceed the sum of the No Action Alternative impacts over 20 years plus those presented in Chapter 6 under any action alternative pursued for treatment and disposal.

The Preferred Alternative for Treatment. A number of the Department's sites (generally sites with small amounts of LLMW) would send their LLMW to other sites for treatment. The sites that would receive these wastes and treat them under the Department's preferred alternative are Hanford, INEL, ORR, and SRS. ANL-E, FEMP, LLNL, LANL, Pantex, PORTS, RFETS, and SNL would treat LLMW onsite.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several Regionalized Alternatives as shown in Table 3.7-1 in Chapter 3. The potential environmental impacts of all alternatives for treatment of LLMW evaluated in the WM PEIS are small. DOE's preferred alternative is generally consistent with the Site Treatment Plans prepared under the FFCAct; these plans include the use of commercial facilities to treat some LLMW. DOE realizes that the compliance orders issued by State and Federal regulators on the basis of these Site Treatments Plans establish the requirements for treatment of DOE's LLMW.

The Preferred Alternative for Disposal. The Department's preferred alternative at this time is to send its LLMW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW or LLMW disposal operations and, except for NTS and LANL, each has relatively large LLMW volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLMW the Department will need to dispose of, there is no need for additional candidate sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation costs that would not be needed at more arid sites. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLMW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLMW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Table 6.16–3 provides potential impacts for the preferred alternative by combining the impacts evaluated in the WM PEIS for the preferred alternative at each site. Although it is not possible to estimate disposal impacts with precision until the disposal sites have been selected, the table provides approximate values and ranges expected for the preferred LLMW alternatives. Treatment and disposal impacts are taken from Volume II site data tables for the preferred alternatives specified in the second and third rows of Table 6.16–3. Values presented in the table for regionalized disposal are the high and low values at each site when impacts are estimated for Hanford, INEL, LANL, NTS, ORR, and SRS under Regionalized Alternative 2 (six disposal sites), Regionalized Alternative 3 (one disposal site—NTS), and the Centralized Alternative (one disposal site—Hanford). These values provide a range for potential impacts. Impact estimates under Regionalized Alternative 3 at NTS and the Centralized Alternative at Hanford provide an upper limit for the range of impacts at these sites, using impacts that result when all LLMW is disposed of at one site—NTS or Hanford. The preferred disposal alternative would distribute disposal impacts over two to three sites, lowering values shown for NTS or Hanford.

Table 6.16–3. The Preferred LLMW Alternative — Selected Impacts

Impact Area	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Total
Preferred alternative	T	D	R1[a]	D	R1	R4	D	D	R1[a]	R2	R2	D	D	D	D	R1	R1[a]	
	D[b]	—	—	—	R	R	—	R	R	R	—	—	—	—	—	R	—	—
Worker physical hazard fatalities	T	6.4E-03	4.0E-03	1.6E-01	4.8E-01	8.8E-01	2.7E-01	2.0E-01	4.6E-02	4.8E-01	1.3E-02	3.8E-02	4.8E-01	6.2E-01	5.1E-03	3.3E-01	3.2E-03	4.0E+00
	D	—	—	—	0.0E+00–<1.5E-01	0.0E+00–5.5E-02	—	0.0E+00–1.3E-01	0.0E-00–<8.4E-02	0.0E+00–5.6E-02	—	—	—	—	—	0.0E+00–1.0E-01	—	8.4E-02–4.2E-01
	Total	6.4E-03	4.0E-03	1.6E-01	4.8E-01–<6.3E-01	8.8E-01–9.4E-01	2.7E-01	2.0E-01–3.3E-01	4.6E-02–<1.3E-01	4.8E-01–5.4E-01	1.3E-02	3.8E-02	4.8E-01	6.2E-01	5.1E-03	3.3E-01–4.3E-01	3.2E-03	4.1E+00–4.4E+00
Worker cancer fatalities	T	6.7E-05	5.7E-05	2.9E-04	1.2E-01	1.2E-01	7.8E-03	1.6E-03	2.9E-03	1.2E-01	1.5E-04	3.4E-04	1.4E-03	1.0E-03	3.3E-04	1.1E-01	2.8E-05	4.9E-01
	D	—	—	—	0.0E+00–<3.6E-01	0.0E+00–1.7E-01	—	0.0E+00–1.2E-02	0.0E-00–<3.9E-01	0.0E+00–9.3E-02	—	—	—	—	—	0.0E+00–3.9E-02	—	3.6E-01–5.2E-01
	Total	6.7E-05	5.7E-05	2.9E-04	1.2E-01–<4.8E-01	1.2E-01–2.9E-01	7.8E-03	1.6E-03–1.4E-02	2.9E-03–<3.9E-01	1.2E-01–2.1E-01	1.5E-04	3.4E-04	1.4E-03	1.0E-03	3.3E-04	1.1E-01–1.5E-01	2.8E-05	8.5E-01–1.0E+00
Offsite population cancer fatalities	T	1.7E-05	5.2E-08	2.6E-05	1.4E-03	6.7E-04	1.5E-01	5.9E-04	6.4E-09	1.2E-03	8.1E-07	3.5E-05	2.7E-06	8.8E-05	1.4E-04	1.8E-03	1.7E-07	1.6E-01
Radionuclides requiring constraints to meet groundwater standards	D	—	—	—	None or U-238	None	—	None	None	None or PU-239 PU-240 TC-99 U-238	—	—	—	—	—	None or U-238	—	0-3 sites exceed

Table 6.16-3. The Preferred LLMW Alternative — Selected Impacts—Continued

Impact Area	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Total
Preferred alternative	T	D	R1[a]	D	R1	R4	D	D	R1[a]	R2	R2	D	D	D	D	R1	R1[a]	
	D[b]	—	—	—	R	R	—	R	R	R	—	—	—	—	—	R	—	
Truck radiation fatalities		These numbers reflect intersite transportation results and are not attributable to individual sites																<0.5
Truck nonradiation fatalities																		≤1.0
Highest air pollutant percentage	T	44% NO_2	1% NO_2	22% NO_2	23% PM_{10}	45% PM_{10}	5% PM_{10}	2% NO_2/PM_{10}	25% CO	50% PM_{10}	1% VOC	1% NO_2	13% PM_{10}	107% CO	9% CO	10% PM_{10}	0%	1 site exceeds (RFETS)
	D	—	—	—	—	—	—	—	0-73% CO	—	—	—	—	—	—	—	—	No sites exceed
Cost $ billions	T	0.06	0.01	0.34	0.70	1.87	0.33	0.40	0.18	1.46	0.06	0.15	0.69	1.23	0.07	0.96	0.01	8.5
	D	0	0	0	0-<1.04	0-0.33	0	0-0.42	0-<0.52	0-0.32	0	0	0	0	0	0-0.29	0	0.7-1.6
	Total[c]	0.06	0.01	0.34	0.70-<1.74	1.87-2.20	0.33	0.40-0.82	0.18-<0.70	1.46-1.78	0.06	0.15	0.69	1.23	0.07	0.96-1.25	0.01	9.2-10.1
Truck shipments[d]		20	20	110	40-7,520	1,740-5,840	210	130-2,610	160-9,640	1,660-2,100	50	40	650	2,520	30	110-710	30	10,000-23,770

[a] Wastes from these sites (BNL, NTS, and WVDP) undergo shipment offsite to regional treatment centers.
[b] DOE prefers to further narrow its configuration of disposing sites to two or three sites from these six sites. DOE has no site preferences pending further deliberations with regulators and stakeholders. For the preferred disposal alternative, disposal volumes would range between zero and quantities disposed of in the Regionalized Alternative 2 at INEL, LANL, ORR, and SRS. At NTS, disposal volumes would range between zero and a quantity less than those evaluated for Regionalized Alternative 3. At Hanford, disposal volumes would range between zero and a quantity less than those evaluated in the Centralized Alternative.
[c] Costs for truck transportation (≤ $.06 billion) were added to these site totals for the total alternative cost as presented in Table 6.16-2.
[d] Total one-way shipments between two sites, as defined for shipment totals in Table 6.16-2, are (10,000 - 23,770) ÷ 2 = 5,000 - 11,885 shipments.

Chapter 6
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Proposed Waste Management Actions at Each Site Under the Low-Level Mixed Waste Alternatives[a]

Alternatives	Number of Sites T	Number of Sites D	ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
No Action	3	0	S	S	S	S	TS	S	S	S	TS	S	S	S	S	S	TS	S
Decentralized	37[b]	16	TD	TD	TD	TD	TDα[c]	TDα	TDα	TDα	TD	TD	TD	TD	TDα	TD	TDα	TD
Regionalized 1	11	12			TD	TD	TDα	TDα	TDα	Dα	TD	TD	TD	TD	TDα		TDα	
Regionalized 2	7	6				TD	TDα	TDα		Dα	TD			T	Tα		TDα	
Regionalized 3	7	1				T	Tα	T		Dα	T			T	Tα		Tα	
Regionalized 4	4	6				TD	TDα	Dα		Dα	TD						TDα	
Centralized	1	1				TDα												

Notes: T = treatment to meet land disposal restrictions; D = disposal; S = indefinite storage. A blank indicates that no treatment or disposal takes place at a site. All sites have wastewater treatment capability as needed.

[a] The actions shown are for contact-handled (CH) wastes. Remote-handled (RH) wastes would be treated and disposed of onsite at the Hanford Site, INEL, ORR, and SRS in all alternatives except No Action. RH waste is stored under No Action. Facilities with the α symbol treat or dispose of contact-handled alpha and nonalpha waste.

[b] Although 37 sites generate LLMW, only 17 have been designated major sites in the WM PEIS (see Section 1.6.1 for details).

[c] Treatment and disposal facilities identified for one site with the α symbol can manage both alpha and nonalpha waste.

CHAPTER 7
Impacts of the Management of Low-Level Waste

Chapter 7 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for low-level waste (LLW). This chapter provides information on existing and anticipated LLW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to LLW characteristics and the treatment and disposal technologies considered, as well as the rationale for selecting the specific sites analyzed under each alternative. This chapter discusses the human health risks, environmental impacts, and costs of the alternatives, and provides a comparison of them.

The methods used to evaluate impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the LLW analysis are contained in a technical report entitled "Low-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the appendices in Volumes III and IV and the technical reports provided in Chapter 15.

7.1 Background

- *LLW includes all radioactive waste not classified as High-Level Waste, Transuranic Waste, Spent Nuclear Fuel, or byproduct tailings.*
- *LLW is currently generated, projected to be generated, or stored at 27 DOE sites as a result of nuclear weapons technology production and dismantlement, nuclear reactor operations, environmental restoration activities, and research.*
- *DOE will need to manage an estimated 1.5 million cubic meters of LLW over the next 20 years.*
- *DOE must select treatment and disposal sites for LLW.*

7.1.1 DEFINITION AND ORIGIN

Low-level waste (LLW) is defined as all radioactive waste not classified as either HLW, TRUW, spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section 11 (e) (2) of the Atomic Energy Act of 1954 [42 USC 2011 *et seq.*]) and not containing hazardous or toxic wastes under RCRA or TSCA. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as LLW provided that the concentration of transuranics is less than 100 nanocuries per gram. Since the Manhattan Project during World War II, LLW has been generated by DOE and its predecessor agencies from a variety of activities including weapons production, nuclear reactor operations, environmental restoration activities, and research.

DOE also has the responsibility for two other classes of waste frequently categorized as LLW: special case waste, which is waste generated by DOE that does not fit into any typical LLW management activity (i.e., treatment, storage, and disposal), and commercially generated Greater-Than-Class-C (GTCC) LLW. However, because special case waste has unique site-specific considerations and the GTCC LLW program has not been fully defined, these LLW groups are excluded from the WM PEIS analysis (see discussion in Chapter 1, Section 1.5.6).

7.1.2 Volumes and Locations

Approximately 1.5 million cubic meters of LLW is generated, projected to be generated, or stored at 27 DOE sites. Table 7.1–1 presents the total estimated LLW volumes at those sites. LLW volume data are derived primarily from data in the 1992 Integrated Data Base (IDB) (DOE, 1992) and the Waste Management Information System (WMIS) (ORNL, 1992). (Details of the amounts and characteristics of LLW are provided in ANL [1996].) Although 27 DOE sites manage LLW, 7 sites generate more than 80% of the LLW load: the Hanford Site, INEL, LANL, ORR, Paducah, Portsmouth, and SRS. Figure 7.1–1 presents the total LLW volumes at the 16 major sites considered under the LLW alternatives and illustrates LLW distribution across the country. The naval shipyards (i.e., Norfolk, Pearl Harbor, Puget Sound, and Portsmouth) generate small quantities of LLW not included here. Impacts from the minor amounts of naval shipyard LLW are not expected to affect the overall conclusions reached in the WM PEIS.

Owing primarily to improvements in waste characterization, projected waste volumes and inventories of LLW have changed since the analysis of these wastes was carried out for the WM PEIS. Updated LLW volumes for all sites were derived from information in the IBD Report–1994 (DOE, 1995c) and are given in Appendix I. The appendix also identifies criteria for reanalyzing site wastes using more recent data, compares the waste load data used in the Draft WM PEIS with the more recent data and describes DOE's conclusions about the need to analyze the more recent data for specified sites. For five sites—BNL, NTS, ORR, Pantex, and WVDP—updated LLW data are used in the alternatives analyses only when these sites treat their own waste.

Table 7.1–1. Low-Level Waste Volumes [a,b]
(cubic meters)

DOE Site	Inventory	20-Year Projected Generation	Estimated Inventory Plus 20-Years Generation
1. Ames Laboratory	26	80	110
2. Argonne National Laboratory-East	880	5,800	6,700
3. Bettis Atomic Power Laboratory	0	12,000	12,000
4. Brookhaven National Laboratory	560[c]	5,080[c]	5,600[c]
5. Fermi National Accelerator Laboratory	45	1,400	1,500
6. Fernald Environmental Management Project	d	d	d
7. Hanford Site[e]	0	89,000	89,000
8. Idaho National Engineering Laboratory	3,500	101,000	105,000
9. Kansas City Plant	4	20	24
10. Knolls Atomic Power Laboratory	0	19,000	19,000
11. Lawrence Berkeley Laboratory	53	1,200	1,300
12. Lawrence Livermore National Laboratory[g]	780	2,800	3,600
13. Los Alamos National Laboratory	0	150,000	150,000
14. Mound Plant	1,600	37,000	38,000
15. Nevada Test Site	270[c]	1,400[c]	1,700[c]
16. Oak Ridge Reservation	20,000[c]	250,000[c]	270,000[c]
17. Paducah Gaseous Diffusion Plant	5,300	45,000	50,000
18. Pantex Plant	210[c]	2,440[c]	2,700[c]
19. Pinellas Plant	16	1,300	1,300
20. Portsmouth Gaseous Diffusion Plant	1,500	96,000	97,000
21. Princeton Plasma Physics Laboratory	2	220	220
22. RMI Titanium Company	2,500	48,000	51,000
23. Rocky Flats Environmental Technology Site	2,400	39,000	41,000
24. Sandia National Laboratories-New Mexico[h]	680	1,800	2,500
25. Savannah River Site	11,000	500,000	510,000
26. Stanford Linear Accelerator Center	2,200	280	2,500
27. West Valley Demonstration Project	14,000[c]	28,000[c]	42,000[c]
Total	67,500	1,440,000	1,500,000

[a] Volume data are rounded from field estimates and columns may not add. Updated inventories and waste generation rates are summarized in Appendix I, "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW."
[b] Potential waste to be generated by environmental restoration activities are not included in the totals in this table. See Section 7.15 for a discussion of environmental-restoration-generated LLW.
[c] Data from the IDB Report–1994 were used in the analysis (DOE, 1995c).
[d] Waste is ER waste only; no WM waste is generated at Fernald.
[e] Excludes LLW fraction of the Hanford Site tank wastes.
[f] Includes Argonne National Laboratory-West and Naval Reactor Facility.
[g] Includes Sandia National Laboratories, California.
[h] Includes Inhalation Toxicology Research Institute.
[i] Excludes SRS saltstone—29,600 m^3/yr.
Sources: DOE (1992) and ORNL (1992), except where noted.

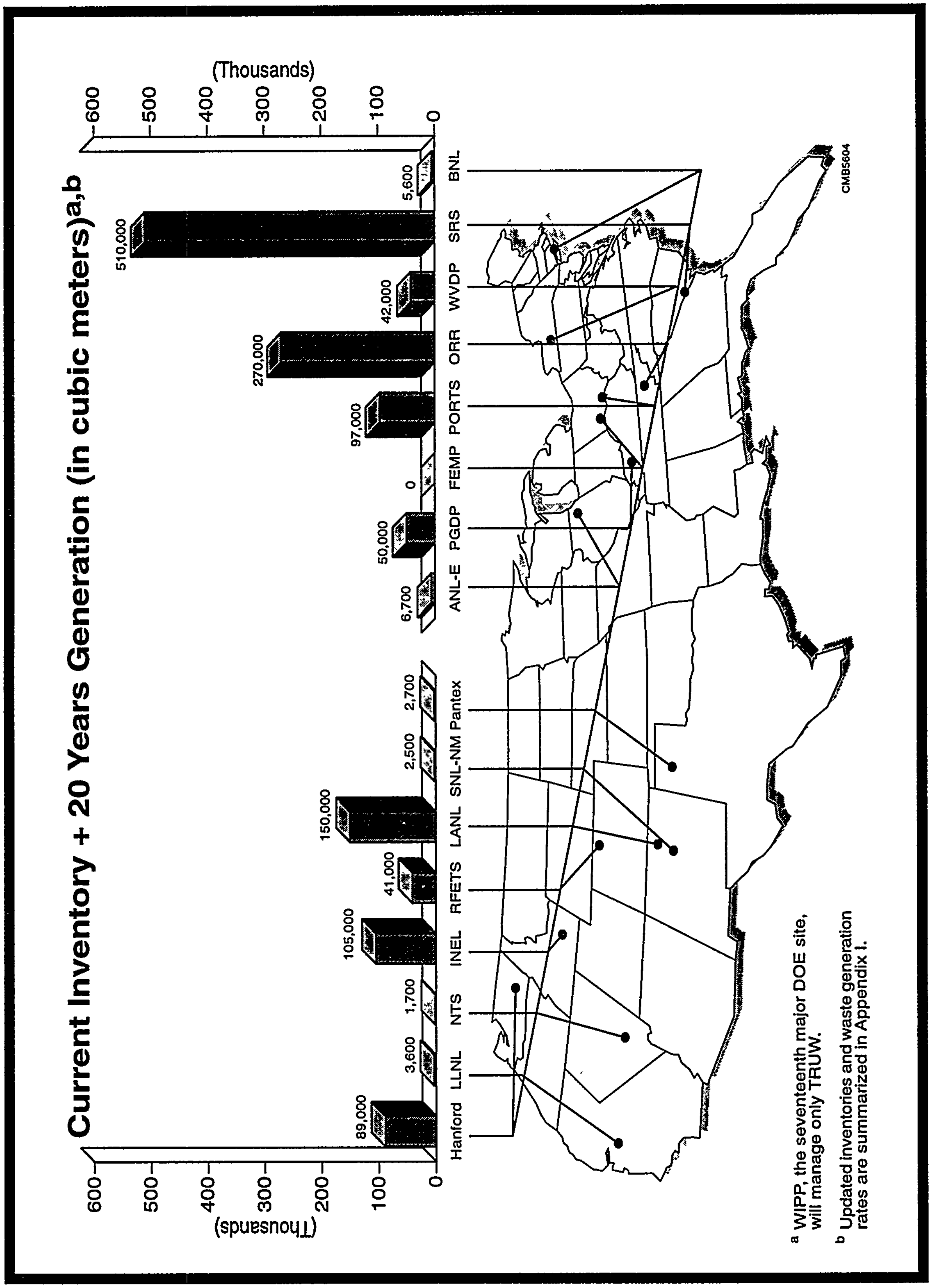


Figure 7.1-1. Low Level Waste—Total Inventory and Generation

7.1.3 EXISTING AND PLANNED FACILITIES AVAILABLE AT DOE SITES

DOE used the existing and planned LLW facilities and capacities listed in Table 7.1–2 to establish the baseline capacities for treatment and disposal and to determine the need for new or expanded facilities. Planned facilities include only the facilities for which a Title II design has been initiated.

Analysis in the WM PEIS assumes use of existing and planned facilities until their capacities are met. If additional capacity is needed, use of new generic facilities is assumed. These conceptual facilities provide the difference in TSD capacity between the baseline reported in Table 7.1–2 and what is necessary to manage the particular LLW stream which a given site would receive under any given alternative.

Table 7.1–2. Capacities of Existing and Planned LLW Facilities[a]

	Treatment (m^3/yr)				Disposal (m^3/yr)	
Site	Incineration	Size Reduction	Compaction	Solidification	Engineered Disposal	Shallow Land
Hanford			4,040			8,500
INEL	2,300	5,000	5,700	27,770		3,900
LANL						1,300
NTS						44,900
ORR			1,400		600	
SRS	8,200		4,000	210*	5,370	
LBL			Sufficient for LBL Needs	105		
LLNL		115	1,500			
PGDP				Sufficient for PGDP Needs		
Mound				252		
Pantex			1,083			
RFETS			5,600			
RMI	102					

Note: * = planned capacity; blanks indicate that the treatment or disposal operation does not take place at the specified site.
[a] The capacities of these existing and planned units may be used for several waste types in accordance with site plans.
Source: DOE (1996a).

Conceptual facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). Where necessary for analysis, an assumption was made that the impact of existing facilities essentially reflects the impact of generic facilities.

Eleven sites conduct different degrees of LLW treatment using existing facilities. Size reduction and compaction facilities typically used to reduce the total volume of waste requiring disposal are the most prevalent existing facilities for LLW treatment. Seven DOE sites have operating LLW disposal facilities. Of these, three (INEL, LANL, and ORR) accept only onsite wastes, one (SRS) accepts small amounts of waste from several small generators, and two (the Hanford Site and NTS) accept large quantities of offsite waste from other DOE sites.

7.2 Analytical Methods and Assumptions

The character of the waste is as important as waste volume in determining the potential impacts resulting from LLW management. LLW can contain many different radionuclides in many combinations and can be present in many physical forms ranging from dilute liquids to activated metal equipment. For the purposes of analysis, DOE categorized LLW by radiological and physical properties, and assigned the waste into an appropriate treatability category to calculate risk, costs, and other impacts. This process is further described below.

7.2.1 CHARACTERISTICS

7.2.1.1 Physical

DOE defined the treatment requirements for LLW based on physical characteristics of the waste. Using site data and information contained in the Waste Management Information System database (ORNL, 1992), LLW at each site was characterized into the following 10 treatability categories: solid LLW classified as (1) combustible, (2) noncombustible-noncompactible, (3) noncombustible-compactible, (4) surface-contaminated bulk metal/equipment, (5) activated bulk metal/equipment, (6) sludge/resin, (7) other (wastes that do not fit into the previous categories); liquid LLW classified as either (8) small-volume dilute/aqueous or (9) liquids containing organic materials; and (10) remote-handled (RH) LLW, which requires special shielding during waste handling. These categories determined the treatment and processing techniques required for LLW to produce a final waste form suitable for disposal.

7.2.1.2 Radiological Profiles

After categorizing the waste into the 10 treatability categories, DOE further categorized LLW by its radiological characteristics. Six radiological categories, or radiological profiles, defined in the 1992 Integrated Data Base (DOE, 1992) were assigned to LLW streams at the 16 major sites. These categories, described in Table 7.2–1, identify the radionuclides likely to be encountered based on the origin of the waste. A detailed listing of the radionuclides that compose each radiological category is available in ANL (1996).

7.2.2 TECHNOLOGIES AND TREATMENT PROCESSES

DOE analyzed two treatment strategies for LLW: minimum treatment, defined as the least amount of treatment required to meet applicable requirements for either onsite disposal or transport to another site for disposal; and volume reduction, which reduces the overall disposal volume of LLW using a variety of treatment techniques. Minimum treatment includes solidification of liquids and fines, and packaging.

Table 7.2–1. LLW Radiological Profiles

Category	Description
Uranium/thorium	Waste material primarily containing the naturally occurring radioactive elements of uranium or thorium.
Fission products	Waste containing radionuclides (e.g., cesium-137 and strontium-90) that result when a heavy nucleus is split.
Induced activity	Waste that contains elements that were initially not radioactive but became radioactive as a result of absorbing neutrons (e.g., cobalt-60).
Tritium	Waste material containing trace amounts of tritium (a synthetically produced radioactive isotope of hydrogen).
Alpha	Waste materials contaminated with alpha-emitting (helium nuclei) radionuclides not listed under uranium/thorium or low levels (less than 100 nCi/g) of transuranic isotopes.
Other	Waste material that is combined or undefined.

Volume reduction uses several different available technologies, including thermal treatment, compaction/supercompaction, and size reduction to decrease the volume of combustible and/or compactible LLW. Minimal treatment is used for wastes that are not amenable to the volume reduction technologies.

LLW is treated by one or more treatment processes (or "modules"). Individual modules were linked together to form a complete treatment flow process. Figure 7.2–1 illustrates the treatment flow diagrams which include thermal treatment, solidification, compaction/supercompaction, and size reduction.

Figure 7.2–2 illustrates the percentage of waste that could be treated by each technology under the policies of minimum treatment and volume reduction. Because treatment is based primarily on physical waste characteristics, not all the wastes are eligible for all the treatment technologies.

For LLW disposal, DOE evaluated the impacts associated with both shallow land burial and engineered disposal facilities.

7.2.3 WM PEIS Assumptions: Facilities, Treatment, and Disposal

In addition to the assumptions regarding the physical and radiological characteristics of LLW, DOE made other assumptions to conduct the LLW analysis. These assumptions are summarized below.

Facilities

- The WM PEIS uses a 20-year period for the analysis of waste management operations. Within this 20-year period, new facilities will be constructed within the first 10 years, and inventory waste and annually generated waste will be treated within the following 10-year period.
- In the LLW analysis, each site is assumed to build and operate facilities with capacities sufficient to handle only LLW. This avoids linking results of one waste type to decisions not yet made in another and results in conservative estimates of risk, cost, and impacts. However, the alternatives were structured to accommodate locating LLMW and LLW facilities at the same sites to more accurately reflect the reality of coordinated treatment and disposal. Chapter 11 discusses cumulative effects for sites hosting more than one waste type facility.

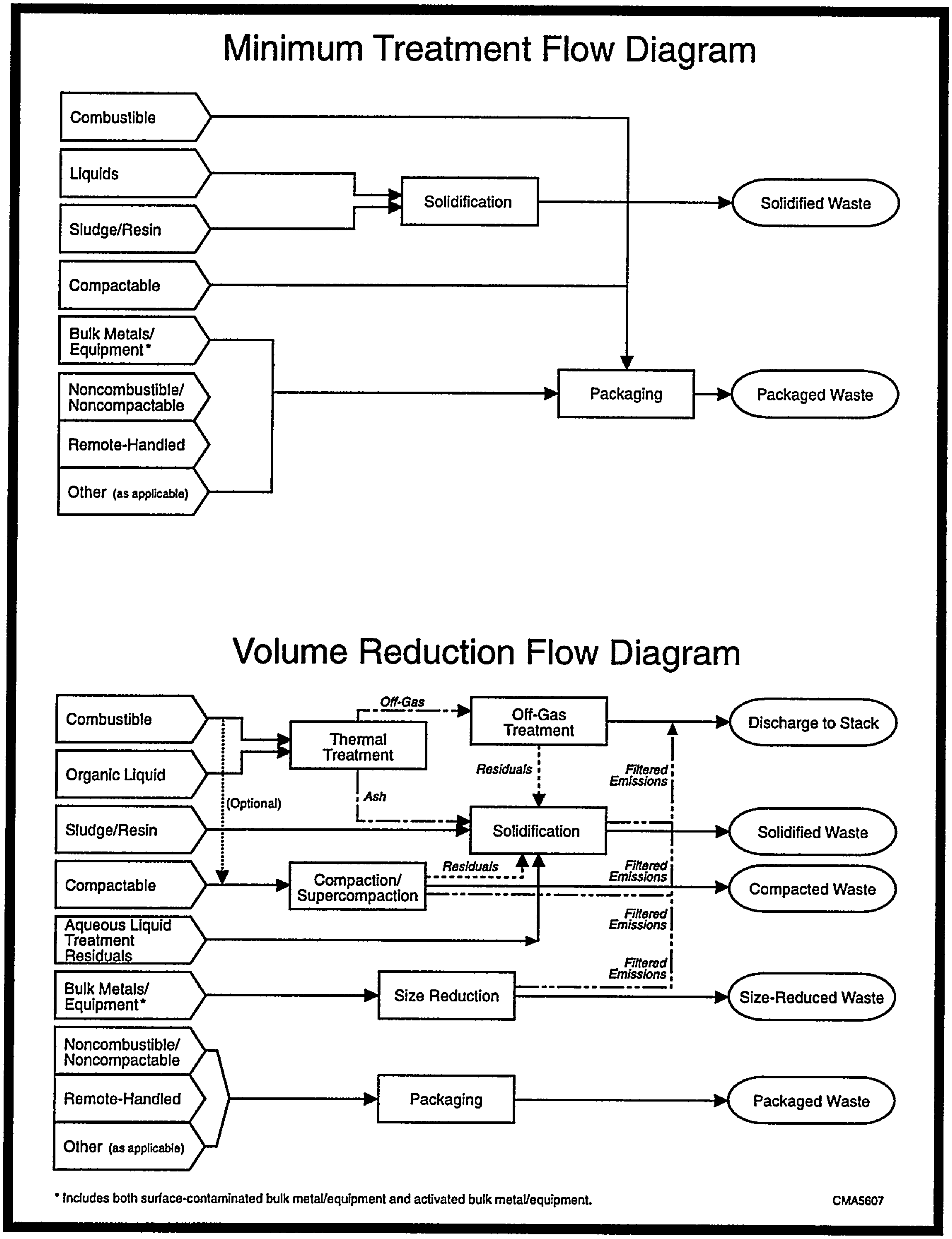


Figure 7.2-1. Low-Level Waste Flow Diagram

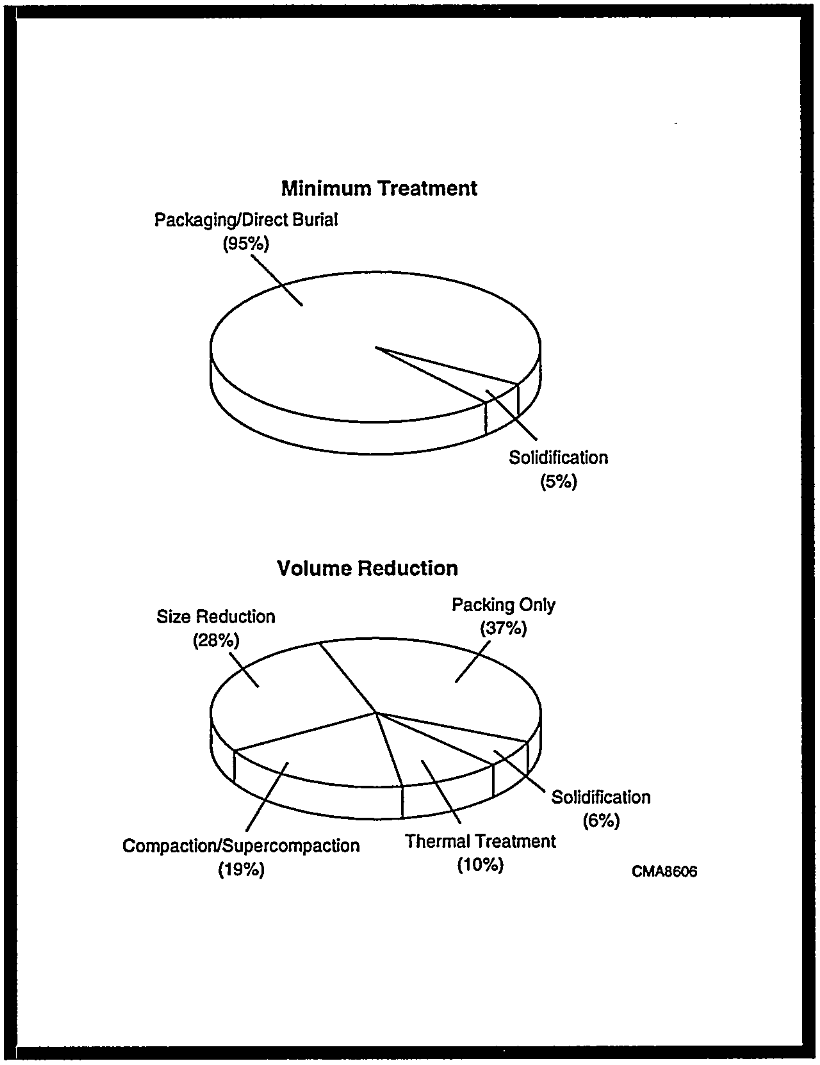


Figure 7.2-2. LLW Treatment Processes

Treatment

- Aqueous liquid LLW treatment facilities are assumed to exist in sufficient capacities at all facilities with wastewater. The sludges (fine material and residuals) from aqueous treatment are to be solidified at the site of generation; therefore, aqueous liquid LLW is not shipped for treatment or disposal in any of the alternatives. LLW sludges resulting from treatment are transported primarily to move the waste to a final disposal location.
- For all alternatives, some treatment is considered practical and will occur at every site in both the minimum treatment and volume reduction approaches.

- LLW storage capacities are sufficient at individual sites or can be expanded to meet future requirements.
- For analytical purposes, incineration was modeled as the representative thermal treatment for LLW.

Disposal

- Two types of disposal were analyzed in the WM PEIS: shallow land burial and engineered disposal. Shallow land disposal is generally used where the groundwater table is far below the surface and therefore was the primary disposal method assumed at western sites, except at RFETS which used aboveground facilities because of shallow groundwater conditions. Engineered concrete structures are typically used for disposal at sites with shallow groundwater and high precipitation rates to reduce potential radionuclide migration. In addition to RFETS, DOE assumed the use of aboveground engineered concrete structures for sites located in the eastern United States, except at SRS which currently uses belowground vaults.

7.2.4 Transportation Analysis and Assumptions

DOE analyzed transportation impacts associated with each alternative. Both truck and rail transportation were analyzed using routing models following the general principle of minimizing distance and transportation time. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines; however, because the routes were determined for the purposes of risk assessment, they do not necessarily represent actual routes that would be used to transport waste in the future. Actual routes would be determined during the transportation planning process described in Section 4.3.10.

In general, the impacts resulting from transportation of radioactive materials are directly proportional to the external dose rate, which is a measure of the external radiation (principally gamma radiation) emitted from the shipment. For analytical purposes, DOE assumed the average dose rate of each shipment would not exceed 1 millirem per hour at 1 meter from the shipping container (consistent with DOE's historical practices), although DOT regulations allow a dose rate of 10 millirem per hour at 2 meters from the container.

7.3 Low-Level Waste Alternatives

The WM PEIS LLW alternatives cover two approaches for solid LLW treatment. As considered in this section, the minimal treatment approach simply includes procedures (e.g., packaging, solidification) that can be employed to enable the waste to meet applicable criteria for LLW transport and/or disposal. All LLW will undergo only minimal treatment at each waste generation site under the Decentralized Alternative, Regionalized Alternatives 1, 3, 6, and 7, and the Centralized Alternatives 1 and 2. The volume reduction approach includes procedures and technologies (e.g., incineration, supercompaction) that would reduce the waste volume prior to undergoing final treatment to meet applicable LLW acceptance criteria. Only certain waste types, such as compactible and combustible LLW, would be amenable to volume reduction technologies. Under the LLW No Action Alternative, Regionalized Alternatives 2, 4, and 5, and the Centralized Alternatives 3, 4, and 5, all generating sites would conduct minimal treatment for their own noncombustible, noncompactible waste streams, while the remaining wastes would undergo volume reduction at designated regional treatment sites prior to final disposition.

The WM PEIS LLW analysis considers 14 alternatives for treatment and disposal facilities within the four broad categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. Treatment and disposal activities vary by alternative and by site. Each of the 14 alternatives was developed in order to capture and quantify the human health risks, environmental impacts, and costs associated with the range of LLW treatment and disposal options available to DOE, and to provide input for decisions about where to locate LLW treatment and disposal facilities. The foldout table at the end of this chapter shows the sites at which LLW would be treated and disposed of under each alternative. This table is designed to be used as a quick reference when reading the LLW impact sections.

In the table at the end of this chapter, the sites identified with a "T" or "D" for treatment or disposal are candidate sites. The evaluation of impacts for treatment or disposal at a candidate site is based on waste that either exists at the site or is routed there from off site. In some alternatives, a candidate site does not receive waste or have waste on site for waste management. In these alternatives, the site is listed as a candidate with a "T" or "D," but there was no impact evaluation.[1]

[1]FEMP is shown as a candidate site for disposal in the Decentralized, Regionalized 1, and Regionalized 2 Alternatives; however, this disposal would be for onsite waste only, if FEMP is determined to have waste management LLW. At present, FEMP does not report waste management LLW (see Section 7.15 and Appendix B).

Transportation of hazardous and radioactive materials, substances, and wastes is governed by the U.S. Department of Transportation, U.S. Nuclear Regulatory Commission (NRC), and U.S. Environmental Protection Agency (EPA) regulations and by the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

In Tables 7.3–1 through 7.3–14, the percentages represent the relative proportion of the waste managed at the respective regional treatment or disposal site that originates from offsite locations. The percentages are developed based on the shipped volumes of LLW. In the Decentralized Alternative, Regionalized Alternatives 1, 3, 6, and 7, and Centralized Alternatives 1 and 2, where all LLW undergoes only minimal treatment at the waste generating site, the percentages are derived from the generating site waste totals and include the small volume increases due to waste solidification or packaging prior to shipment. In the Regionalized Alternatives 2, 4, and 5 and Centralized Alternatives 3, 4, and 5, where volume reduction treatment is conducted on certain wastes, the percentages reflect a more complex set of waste shipping parameters. Under these alternatives, the volume of waste sent to regional treatment sites includes only the LLW streams that are amenable to volume reduction as described in Section 7.2.2. These volumes are then compared with the total volume of waste that is to be treated at the designated regional treatment site. The volume of waste sent from the treatment site to the regional disposal site is calculated based on the reduced waste volume after treatment. Waste from generating sites that is not amenable to volume reduction treatment undergoes only minimal treatment and is then sent directly to the regional disposal site. More detail on the breakdown of LLW by site and waste treatment category and shipment volumes is given in the report by Argonne National Laboratory (ANL, 1996).

7.3.1 NO ACTION ALTERNATIVE

The No Action Alternative provides a baseline for the analysis that approximates the current DOE program. Under the No Action Alternative, LLW would be treated using existing facilities and shipped to one of six authorized DOE disposal sites. Today, most offsite LLW disposal occurs at NTS and the Hanford Site. The six sites currently operating have sufficient unused designated disposal area onsite for the proposed LLW disposal operations, or the disposal area could be expanded as required. Figure 7.3–1 and Table 7.3–1 illustrate the No Action Alternative.

LLW No Action Alternative—(Disposal at 6 Sites)

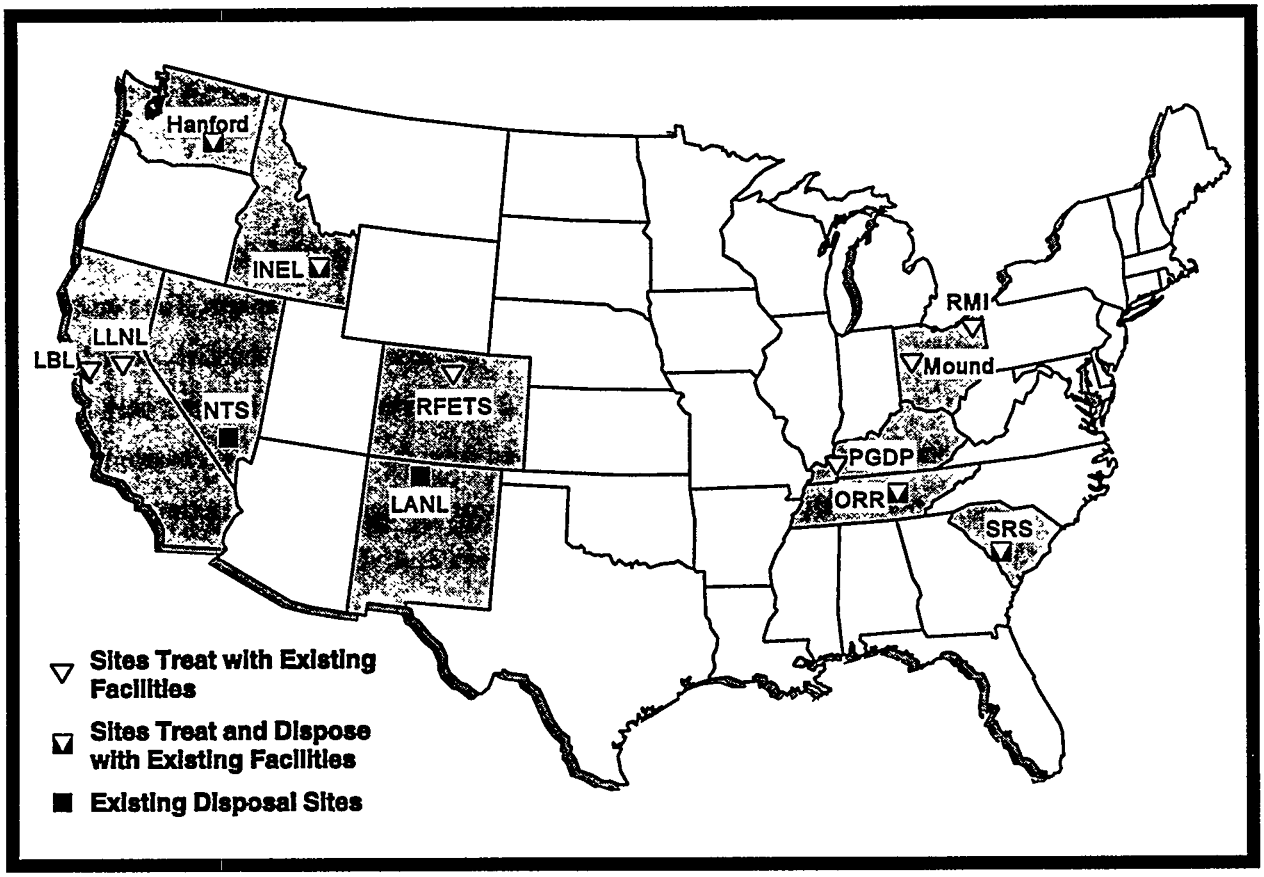


Figure 7.3-1. LLW No Action Alternative

	Generating Sites					
	ORR	Ames, Hanford, ANL-E, BNL, Fermi, LBL, KAPL, PGDP, PORTS, PPPL, SLAC, WVDP, Bettis	INEL	LANL	LLNL, NTS, FEMP, SNL-NM, Pantex, RFETS, RMI, KCP, Mound	Pinellas, SRS
Treat	ALL SITES MINIMUM TREAT AND SOME SITES VOLUME REDUCE USING EXISTING FACILITIES, AS APPLICABLE					
Dispose (% Rec'd From Offsite)	ORR (0)	Hanford (73)	INEL (0)	LANL (0)	NTS (97)	SRS (<1)

Note: Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3-1. LLW No Action Alternative

7.3.2 Decentralized Alternative

The Decentralized Alternative considers disposal at 16 DOE sites following minimum treatment at all 27 LLW sites. Figure 7.3–2 and Table 7.3–2 illustrate the Decentralized Alternative.

7.3.3 Regionalized Alternatives

The Regionalized Alternatives consider minimum treatment at all sites; volume reduction treatment at 11, 7, and 4 sites; and disposal at 12, 6, and 2 sites. Regionalized Alternative 1 considers disposal at 12 sites after minimum treatment at all sites. Regionalized Alternative 2 analyzes the impacts resulting from disposal at the same 12 sites after volume reduction at 11 of these sites. In addition to the Decentralized Alternative, Regionalized Alternatives 1 and 2 are the only alternatives that propose disposal activities at FEMP, LLNL, the Pantex Plant, and Paducah.

The remainder of the LLW Regionalized Alternatives (Regionalized Alternatives 3 through 7) focus most LLW treatment and disposal activities at eight sites: the Hanford Site, INEL, LANL, NTS, ORR, Portsmouth, RFETS, and SRS. Although the sites are the same for most of the Regionalized Alternatives, impacts at the sites vary because of the use of different treatment technologies and incoming waste volumes. For example, Regionalized Alternatives 3 and 4 would dispose of waste at the same six sites. However, Regionalized Alternative 3 would conduct only minimum treatment before disposal, whereas Regionalized Alternative 4 would use volume reduction techniques on the waste that can be reduced, in addition to conducting minimum treatment prior to disposal. Because Portsmouth and RFETS become waste consolidation sites for volume reduction before disposal in Regionalized Alternative 4, they would have a greater potential to experience impacts than under the minimum treatment scenario in Regionalized Alternative 3, although both configurations use the same six sites for disposal. Regionalized Alternative 5 considers volume reduction at four sites and disposal at six, compared to volume reduction at seven sites under Regionalized Alternative 4. Regionalized Alternatives 6 and 7 each consider disposal at two sites after minimum treatment: the Hanford Site and SRS under Regionalized Alternative 6, and NTS and SRS under Regionalized Alternative 7.

Figures 7.3–3 through 7.3–9 and Tables 7.3–3 through 7.3–9 illustrate Regionalized Alternatives 1 through 7.

LLW Decentralized Alternative—(Disposal at 16 Sites)

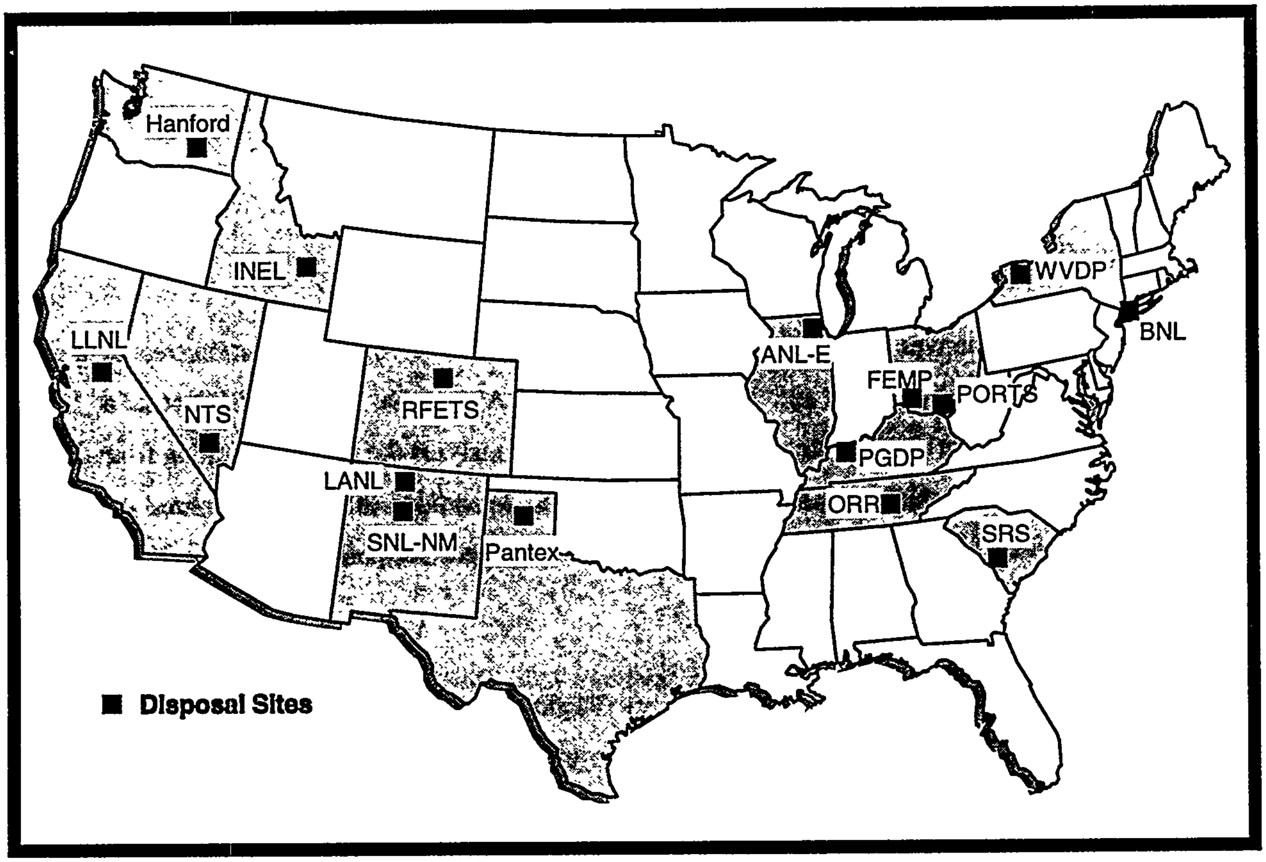


Figure 7.3–2. LLW Decentralized Alternative

	Generating Sites															
	Bettis KAPL PPPL Mound PORTS RMI	ANL-E Ames Fermi	WVDP	BNL	FEMP	Hanford	INEL	KCP PGDP	LANL	LBL LLNL SLAC	NTS	ORR	Pantex	Pinellas SRS	RFETS	SNL-NM[a]
Treat	MINIMUM TREAT AT ALL GENERATING SITES															
Dispose (% Rec'd From Offsite)	PORTS (55)	ANL-E (19)	WVDP (0)	BNL (0)	FEMP (0)	Hanford (0)	INEL (0)	PGDP (<1)	LANL (0)	LLNL (55)	NTS (0)	ORR (0)	Pantex (0)	SRS (<1)	RFETS (0)	SNL-NM (0)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.
[a] Includes ITRI in all alternatives.

Table 7.3–2. LLW Decentralized Alternative

LLW Regionalized Alternative 1—(Disposal at 12 Sites)

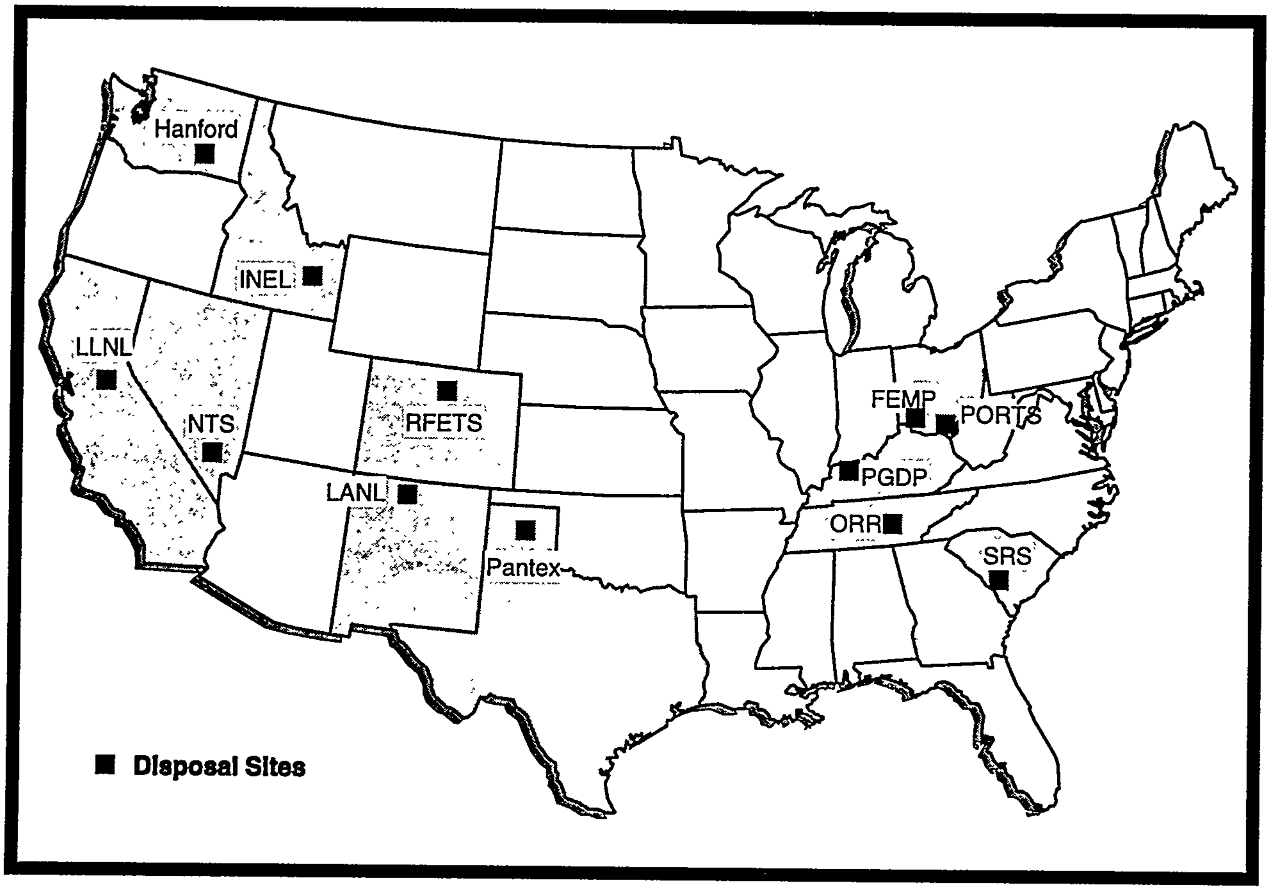


Figure 7.3-3. LLW Regionalized Alternative 1

	Generating Sites												
	Ames, ANL-E, Bettis, BNL, Fermi, KAPL, Mound, PORTS, PPPL, RMI, WVDP	FEMP	Hanford	INEL	KCP, PGDP	LANL, SNL-NM	LBL, LLNL, SLAC	NTS	ORR	Pantex	Pinellas, SRS	RFETS
Treat	MINIMUM TREAT AT ALL GENERATING SITES											
Dispose (% Rec'd From Offsite)	PORTS (61)	FEMP (0)	Hanford (0)	INEL (0)	PGDP (<1)	LANL (2)	LLNL (55)	NTS (0)	ORR (0)	Pantex (0)	SRS (<1)	RFETS (0)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3-3. LLW Regionalized Alternative 1

LLW Regionalized Alternative 2—(Treatment at 11 Sites; Disposal at 12)

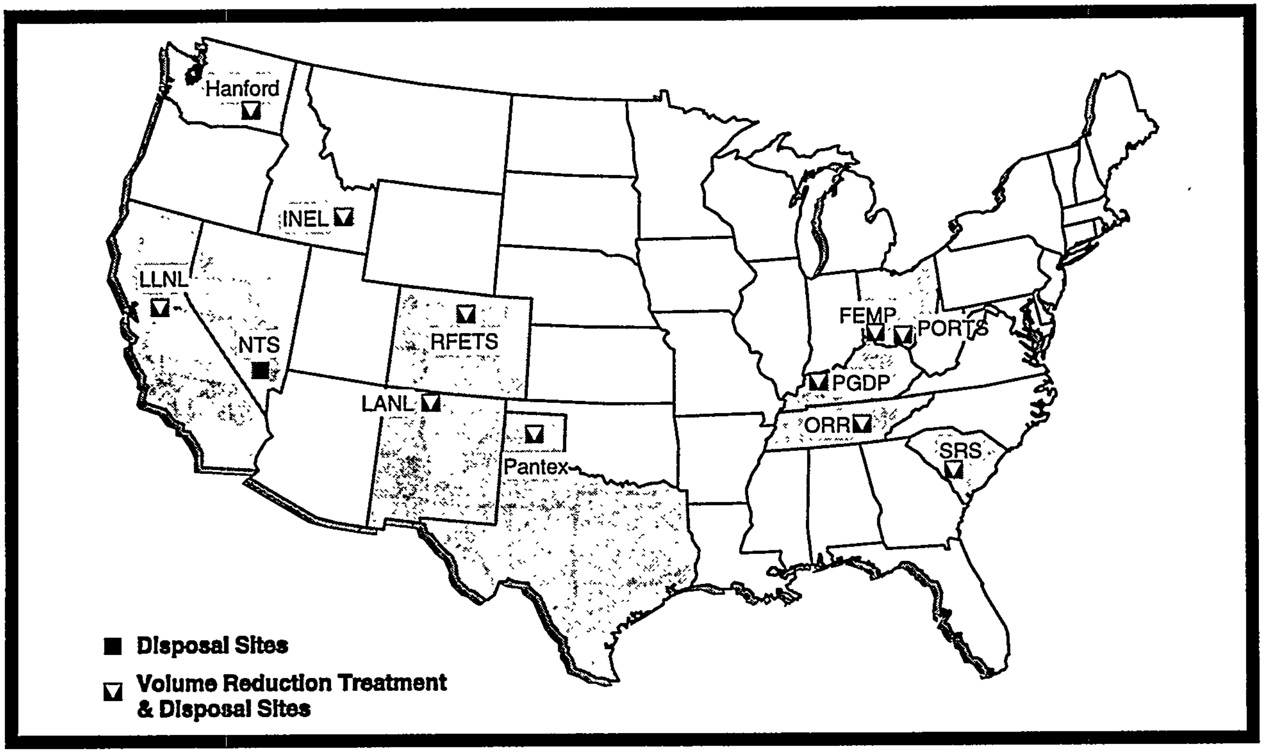


Figure 7.3–4. LLW Regionalized Alternative 2

	Generating Sites												
	Bettis, BNL, KAPL, PORTS, PPPL, RMI, WVDP	Ames, ANL-E, Fermi, Mound	FEMP	Hanford	INEL, NTS	KCP, PGDP	LBL, LLNL, SLAC	LANL, SNL-NM	NTS[a]	ORR	Pantex	Pinellas, SRS	RFETS
Treat (% Rec'd From Offsite)	PORTS (27)	FEMP (100)		Hanford (0)	INEL (0)	PGDP (<1)	LLNL (55)	LANL (2)		ORR (0)	Pantex (0)	SRS (<1)	RFETS (0)
Dispose (% Rec'd From Offsite)	PORTS (90)		FEMP[b] (ND)	Hanford (0)	INEL (0)	PGDP (<1)	LLNL (55)	LANL (2)	NTS (0)	ORR (0)	Pantex (0)	SRS (<1)	RFETS (0)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. All sites minimum treat those waste streams that cannot be volume reduced, and send that waste to disposal at the volume reduction site, if applicable, or to another disposal site. Percentage of waste a site would receive from offsite is indicated in parentheses.

[a] LLW requiring minimum treatment only.

[b] FEMP should be viewed as a candidate disposal site for this alternative; whether waste will be disposed of there is contingent on whether there is WM waste onsite. ND = not determined.

Table 7.3–4. LLW Regionalized Alternative 2

LLW Regionalized Alternative 3—(Disposal at 6 Sites)

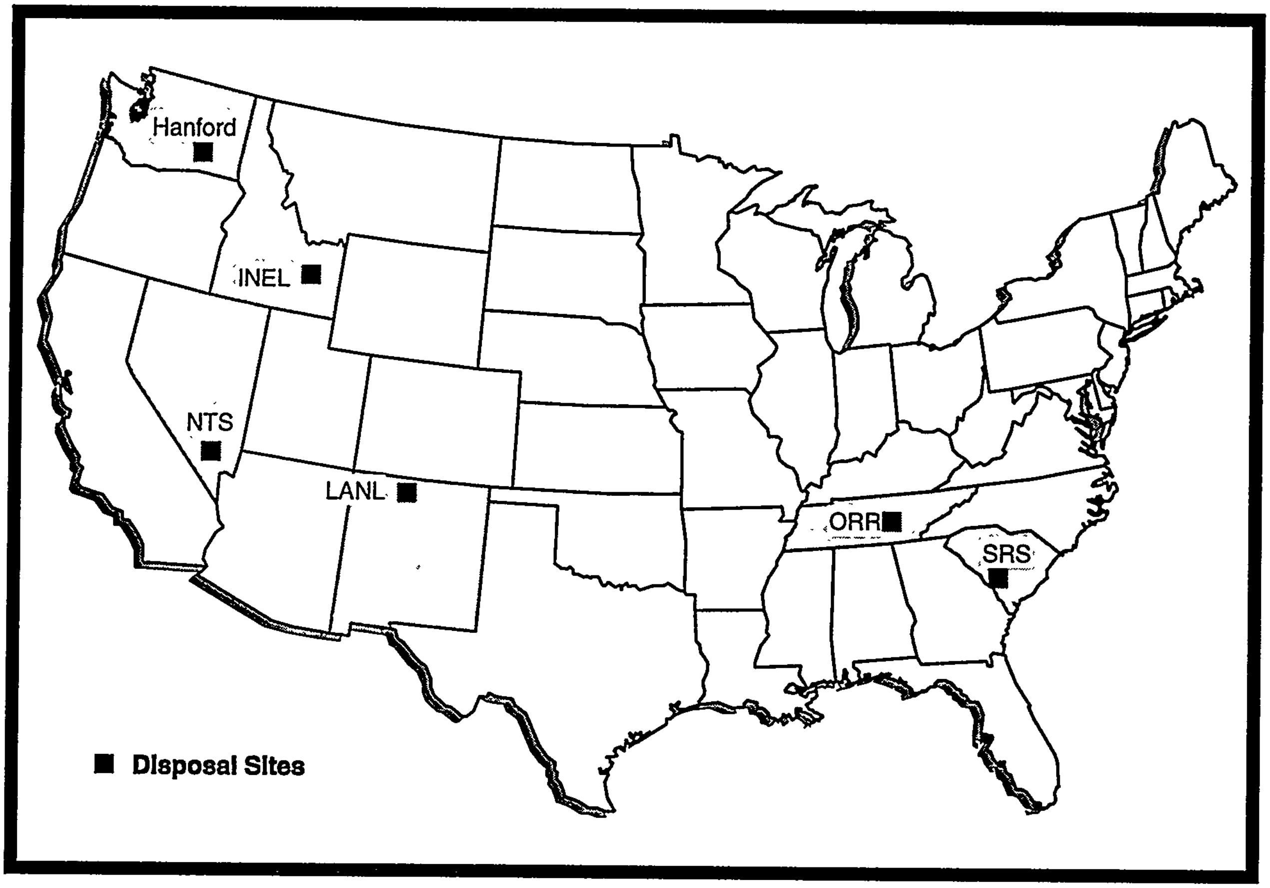


Figure 7.3-5. LLW Regionalized Alternative 3

	Generating Sites					
	Ames, ANL-E, Bettis, BNL, FEMP, Fermi, RMI, KAPL, PGDP, PORTS, PPPL, KCP, Mound, ORR, WVDP	[1] Hanford	INEL	LANL, Pantex, RFETS, SNL-NM	LBL, LLNL, NTS, SLAC	Pinellas, SRS
Treat	MINIMUM TREAT AT ALL GENERATING SITES					
Dispose (% Rec'd From Offsite)	ORR (45)	Hanford (0)	INEL (0)	LANL (24)	NTS (80)	SRS (<1)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3-5. LLW Regionalized Alternative 3

LLW Regionalized Alternative 4—(Treatment at 7 Sites; Disposal at 6)

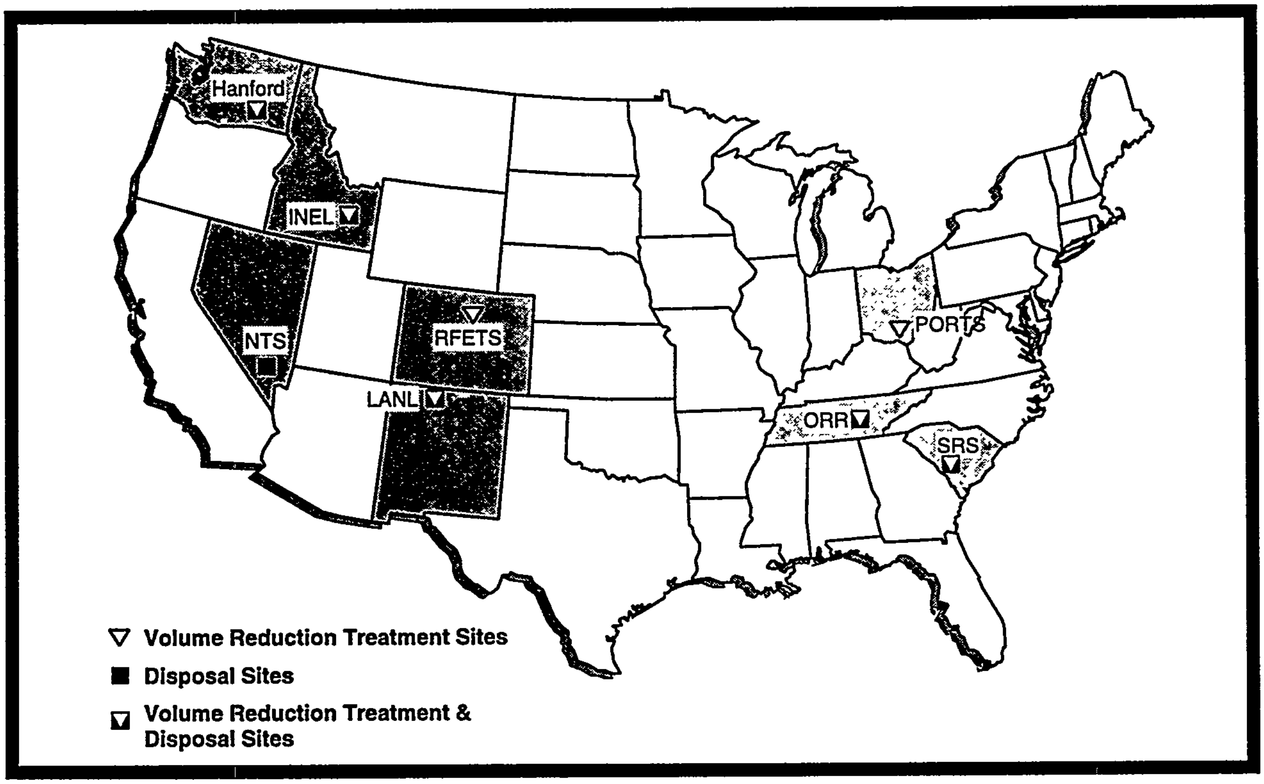


Figure 7.3-6. LLW Regionalized Alternative 4

	Generating Sites							
	Ames, ANL-E, Bettis, BNL, Fermi, FEMP, KAPL, KCP[a], Mound, PORTS, PPPL, RMI, WVDP	ORR, PGDP	Hanford, LBL, LLNL, SLAC	NTS[a], LLNL[a], LBL[a], SLAC[a]	INEL NTS	KCP, RFETS	LANL, Pantex, SNL-NM	Pinellas, SRS
Treat (% Rec'd From Offsite)	PORTS (30)	ORR (4)	Hanford (3)		INEL (1)	RFETS (<1)	LANL (<1)	SRS (<1)
Dispose (% Rec'd From Offsite)	ORR (60)		Hanford (12)	NTS (80)	INEL (1)	LANL (6)		SRS (<1)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. All sites minimum treat those waste streams that cannot be volume reduced, and send that waste to disposal at the volume reduction site, if applicable, or to another disposal site. Percentage of waste a site would receive from offsite is indicated in parentheses.
[a] LLW requiring minimum treatment only.

Table 7.3-6. LLW Regionalized Alternative 4

LLW Regionalized Alternative 5—(Treatment at 4 Sites; Disposal at 6)

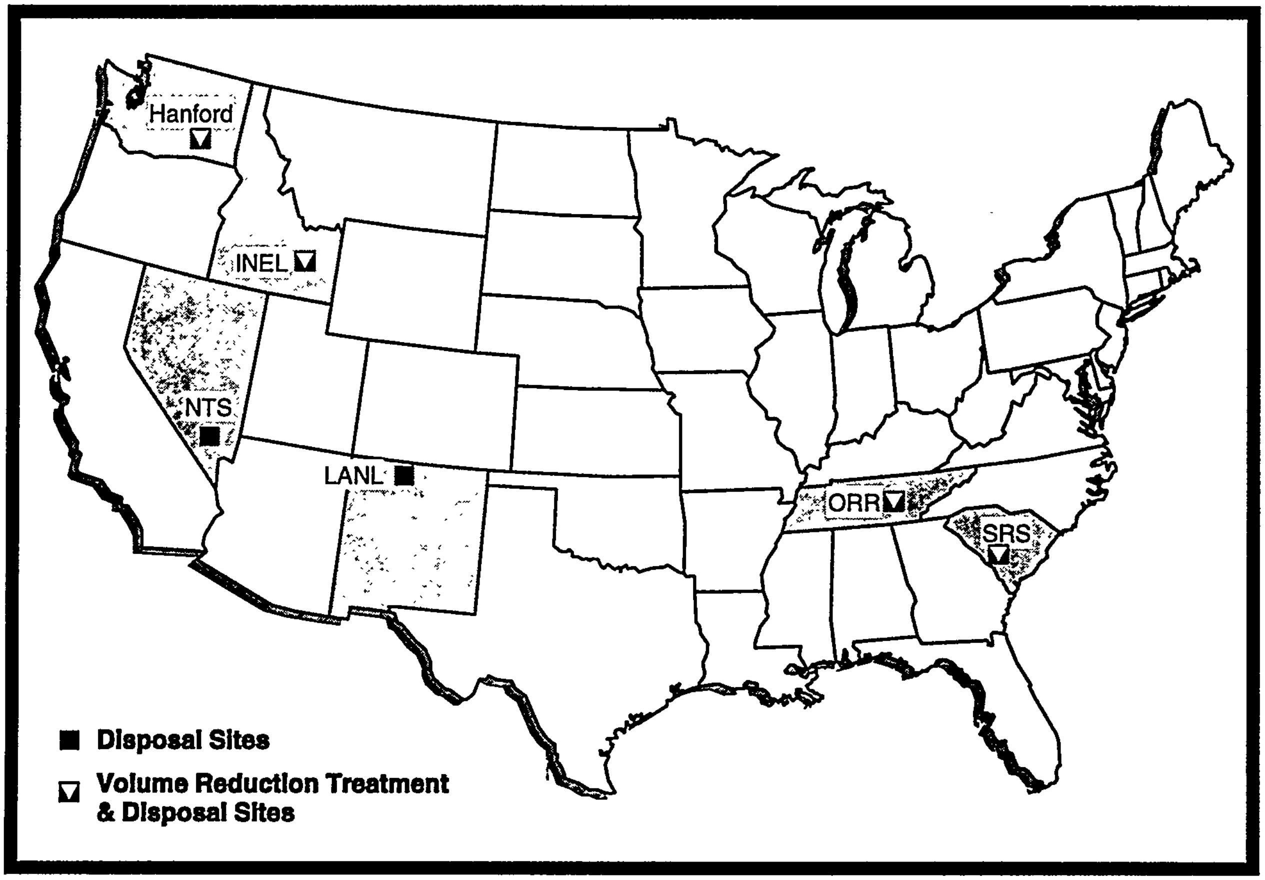


Figure 7.3–7. LLW Regionalized Alternative 5

	Generating Sites					
	Ames, ANL-E, Bettis, BNL, Fermi, FEMP, KCP, KAPL, Mound, ORR, PGDP, PORTS, PPPL, RMI, WVDP	Hanford, LBL, LLNL, SLAC	INEL, LANL, NTS, Pantex, RFETS, SNL-NM	Pinellas, SRS	LLNL[a], LBL[a], SLAC[a], NTS[a]	SNL-NM[a], LANL[a], Pantex[a], RFETS[a]
Treat (% Rec'd From Offsite)	ORR (36)	Hanford (3)	INEL (60)	SRS (<1)		
Dispose (% Rec'd From Offsite)	ORR (60)	Hanford (12)	INEL (80)	SRS (<1)	NTS (80)	LANL (24)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. All sites minimum treat those waste streams that cannot be volume reduced, and send that waste to disposal at the volume reduction site, if applicable, or to another disposal site. Percentage of waste a site would receive from offsite is indicated in parentheses.
[a] LLW requiring minimum treatment only.

Table 7.3–7. LLW Regionalized Alternative 5

LLW Regionalized Alternative 6—(Disposal at 2 Sites)

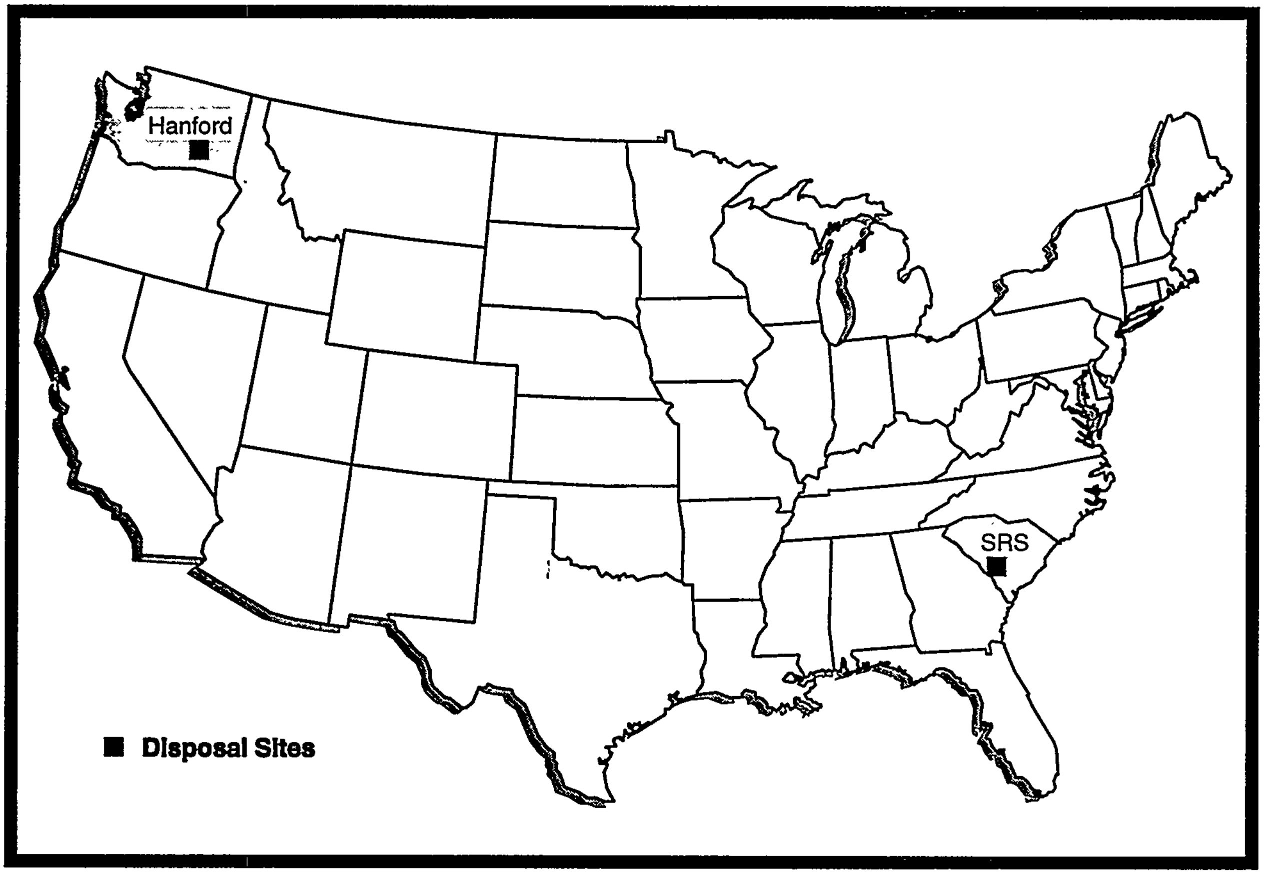


Figure 7.3–8. LLW Regionalized Alternative 6

	Generating Sites	
	Hanford, INEL, LANL, LBL, LLNL, NTS, Pantex, RFETS, SLAC, SNL-NM	Ames, ANL-E, Bettis, BNL, FEMP, Fermi, KAPL, KCP, Mound, ORR, PGDP, Pinellas, PORTS, PPPL, RMI, SRS, WVDP
Treat	MINIMUM TREAT AT ALL GENERATING SITES	
Dispose (% Rec'd From Offsite)	Hanford (75)	SRS (53)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–8. LLW Regionalized Alternative 6

LLW Regionalized Alternative 7—(Disposal at 2 Sites)

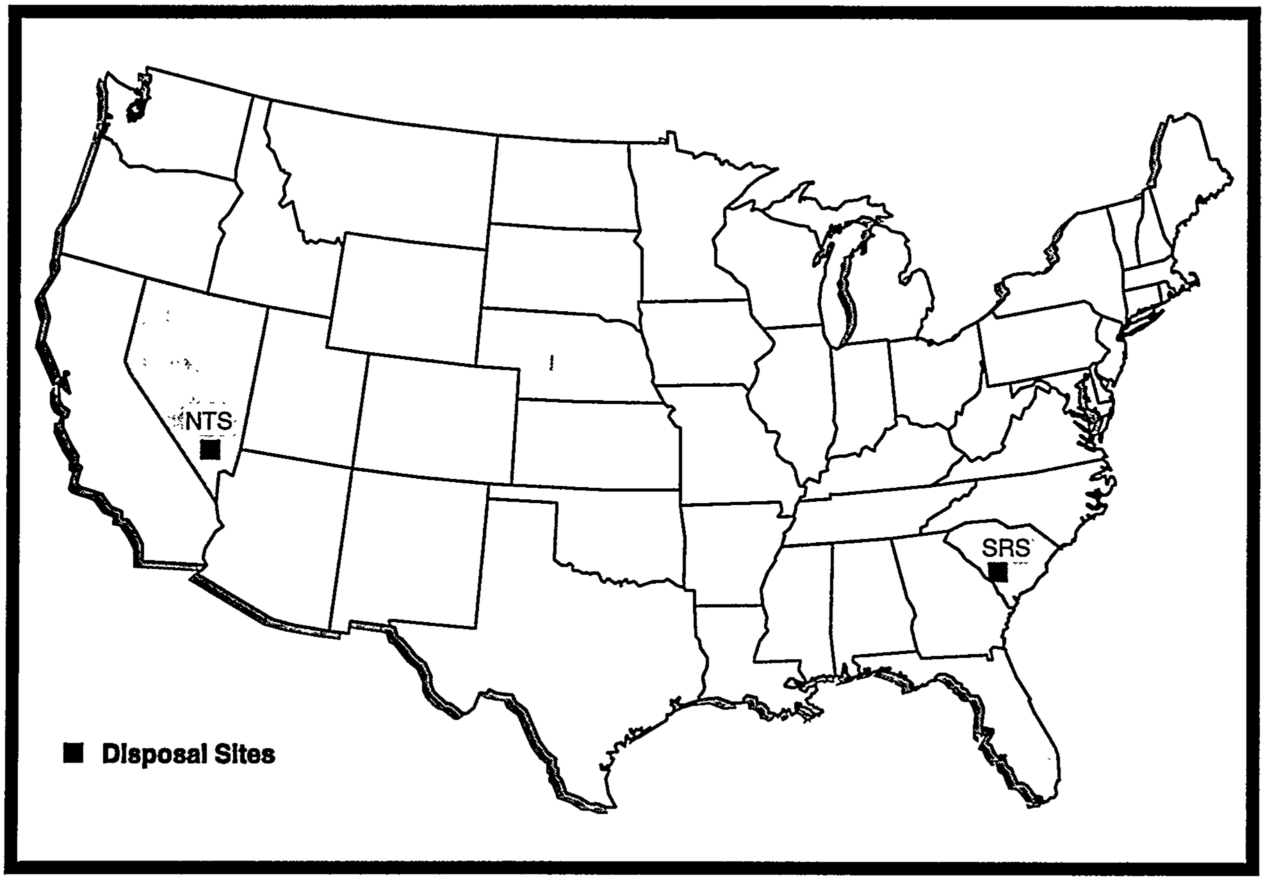


Figure 7.3–9. LLW Regionalized Alternative 7

	Generating Sites	
	Hanford, INEL, LANL, LBL, LLNL, NTS, Pantex, RFETS, SLAC, SNL-NM	Ames, ANL-E, Bettis, BNL, FEMP, Fermi, KAPL, KCP, Mound, ORR, PGDP, Pinellas, PORTS, PPPL, RMI, SRS, WVDP
Treat	MINIMUM TREAT AT ALL GENERATING SITES	
Dispose (% Rec'd From Offsite	NTS (99)	SRS (53)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–9. LLW Regionalized Alternative 7

7.3.4 Centralized Alternatives

DOE analyzed disposal at one site under the Centralized Alternatives. Five alternatives were considered. Centralized Alternatives 1 and 2 would dispose of LLW at the Hanford Site and NTS, respectively, after minimum treatment at all DOE sites. Centralized Alternative 3 evaluates disposal at the Hanford Site after volume reduction treatment at seven sites. In Centralized Alternative 4, NTS would be the single disposal site after volume reduction at the same seven sites considered in Centralized Alternative 3. Centralized Alternative 5 considers both the consolidation of LLW for volume-reducible treatment and disposal at the Hanford Site. Figures 7.3–10 through 7.3–14 provide views of the geographic proximity of the DOE sites involved in the Centralized Alternatives, and Tables 7.3–10 through 7.3–14 describe the Centralized Alternatives 1 through 5.

7.3.5 Rationale for Selection of Sites

DOE generally selected LLW sites as candidates for treatment and disposal facilities if the sites had large volumes of waste. In addition, the alternatives were formulated to consolidate LLW for treatment and disposal at locations which minimized offsite transportation by shipping to the closest available treatment or disposal site.

Because of the interrelationship between LLW and LLMW, DOE used the same treatment (volume reduction) and disposal locations for LLW as those identified for the LLMW alternatives in Chapter 6.

The number of disposal sites considered covers a reasonable range of sites—from 1 to 16, with intermediate numbers of 2, 6, and 12. Sixteen candidate sites were identified to be consistent with those under consideration for LLMW. Likewise, the actual sites used for each LLW alternative mirror those for comparable LLMW alternatives. As discussed in Chapter 6, Section 6.3.5, the LLMW alternatives were selected using criteria established by DOE in coordination with the States under the Federal Facility Compliance Act (FFCAct) (42 USC 6961 *et seq.*).

LLW Centralized Alternative 1—(Disposal at 1 Site)

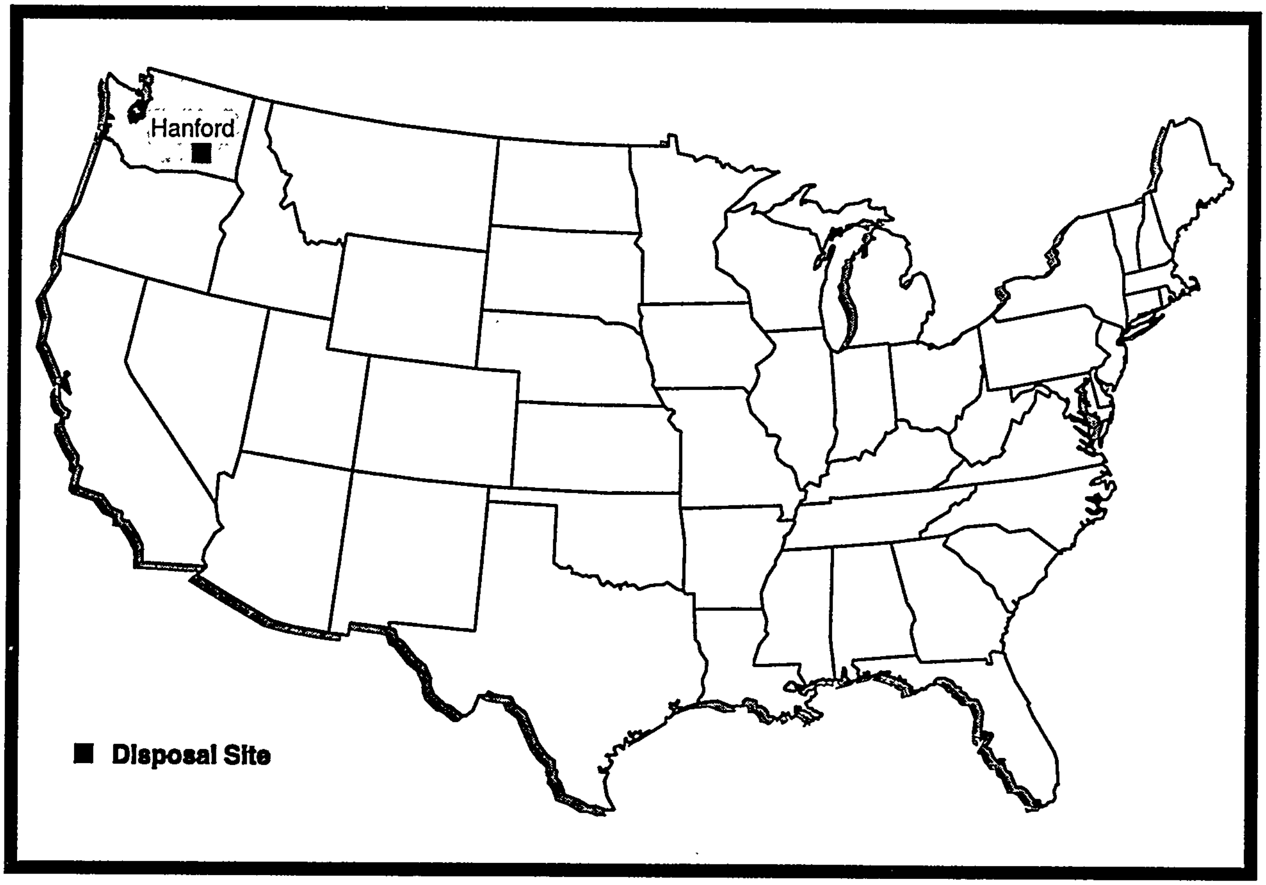


Figure 7.3-10. LLW Centralized Alternative 1

	Generating Sites All Sites
Treat	MINIMUM TREAT AT ALL GENERATING SITES
Dispose (% Rec'd From Offsite)	Hanford (94)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3-10. LLW Centralized Alternative 1

LLW Centralized Alternative 2—(Disposal at 1 Site)

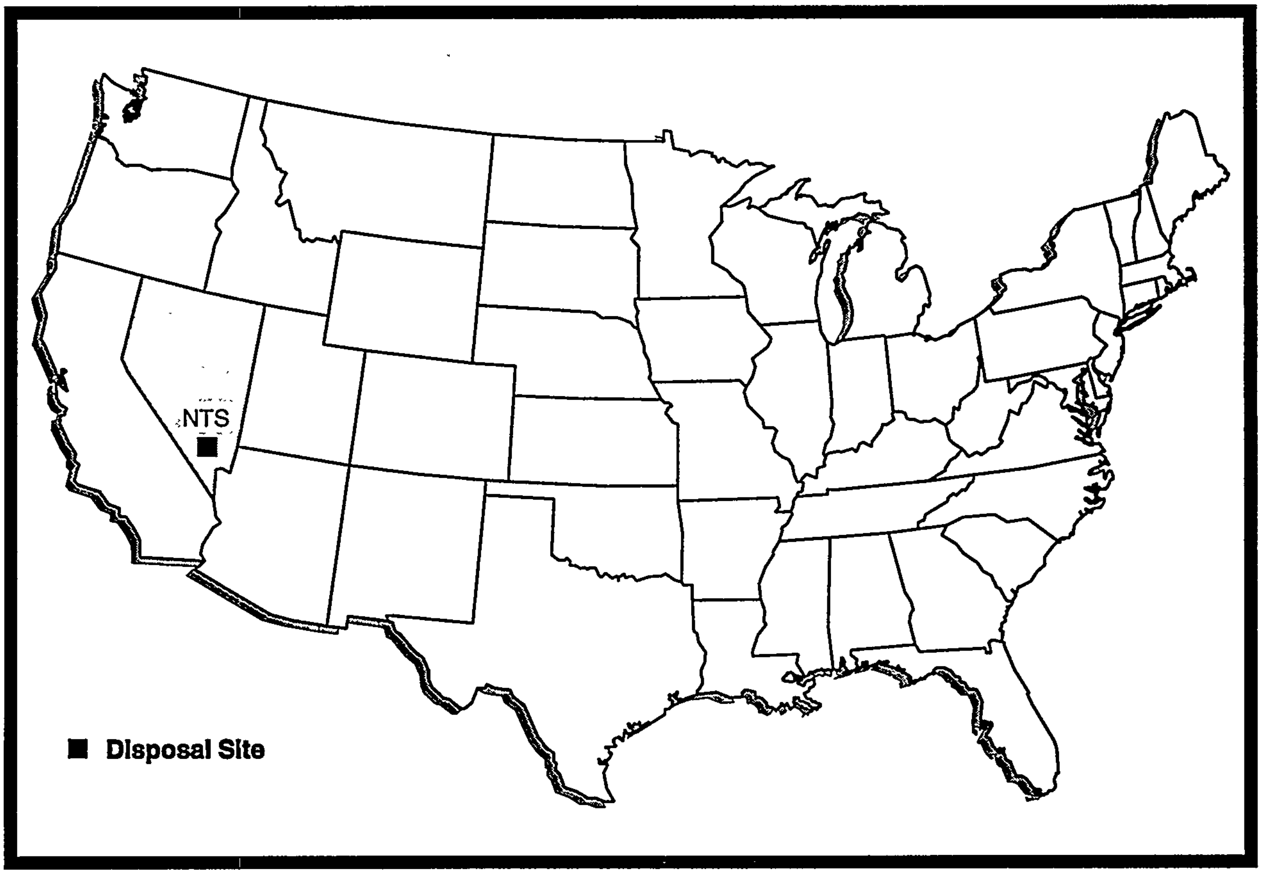


Figure 7.3–11. LLW Centralized Alternative 2

	Generating Sites All Sites
Treat	MINIMUM TREAT AT ALL GENERATING SITES
Dispose (% Rec'd From Offsite)	NTS (99)

Notes: Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–11. LLW Centralized Alternative 2

LLW Centralized Alternative 3—(Treatment at 7 Sites; Disposal at 1)

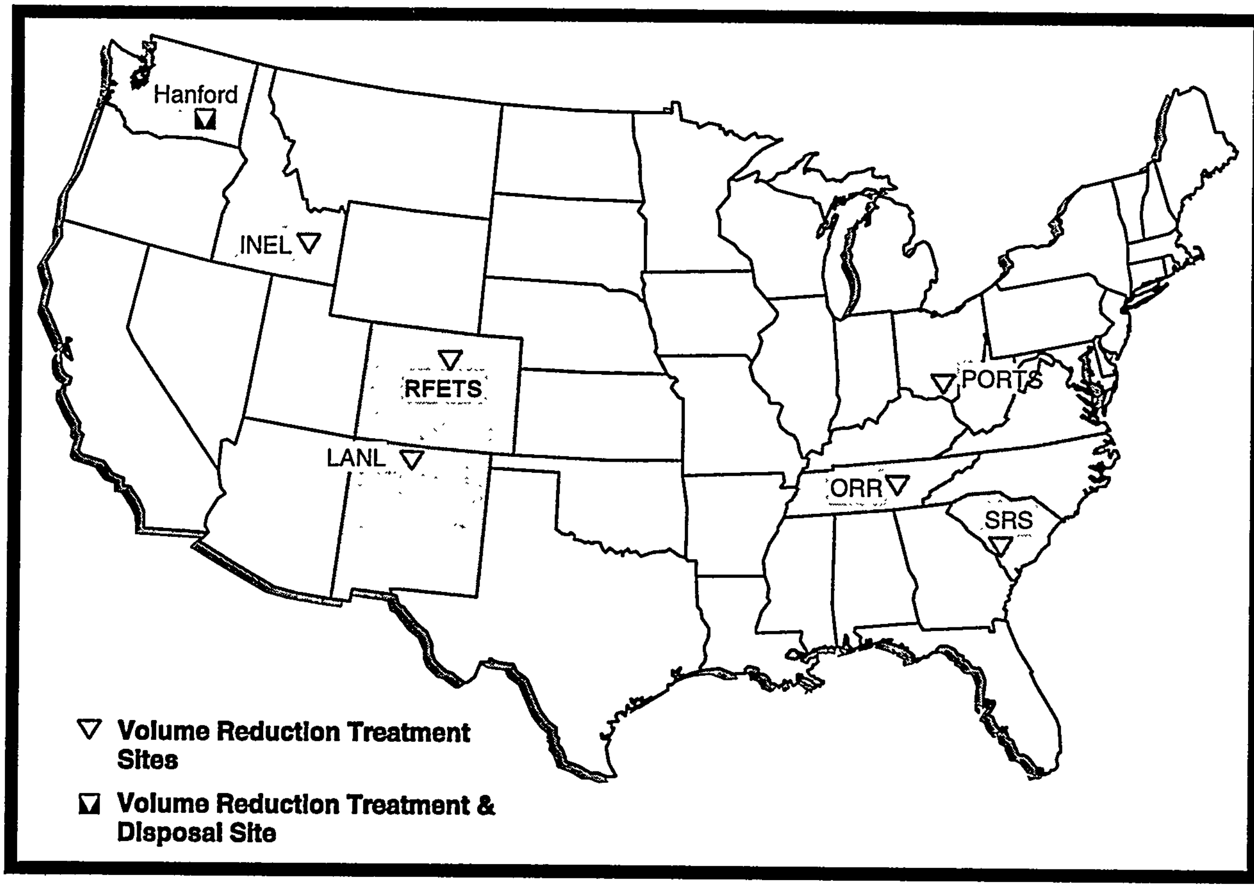


Figure 7.3-12. LLW Centralized Alternative 3

	Generating Sites						
	Ames, ANL-E, Bettis, BNL, Fermi, FEMP, KAPL, Mound, PORTS, PPPL, RMI, WVDP	Hanford, LBL, LLNL, SLAC	INEL NTS	KCP, RFETS	LANL, Pantex, SNL-NM	ORR, PGDP	Pinellas, SRS
Treat (% Rec'd From Offsite)	PORTS (30)	Hanford (3)	INEL (<1)	RFETS (<1)	LANL (<1)	ORR (4)	SRS (<1)
Dispose (% Rec'd From Offsite)	Hanford (97)						

Notes: All sites send minimum treatment wastes directly to the Hanford Site for disposal. Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3-12. LLW Centralized Alternative 3

LLW Centralized Alternative 4—(Treatment at 7 Sites; Disposal at 1)

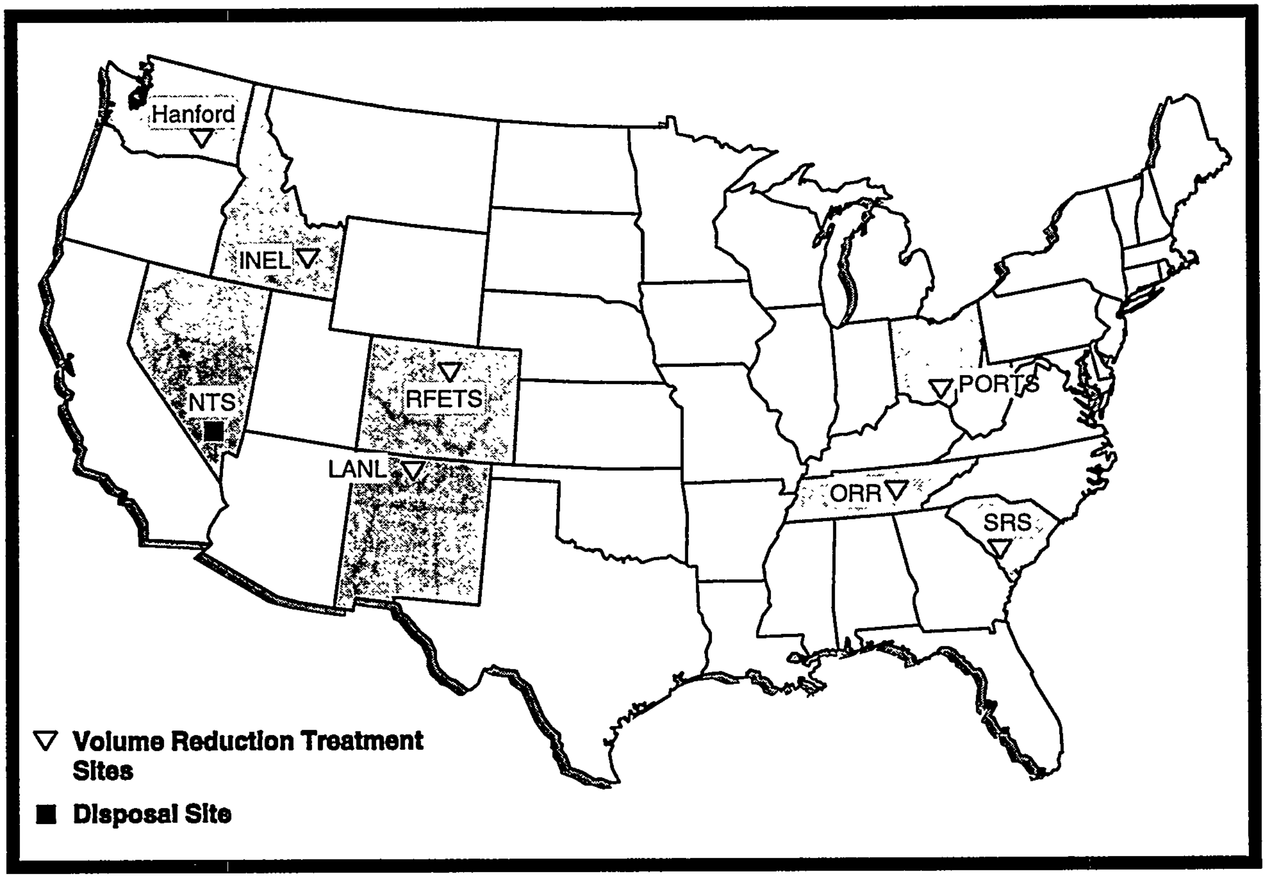


Figure 7.3-13. LLW Centralized Alternative 4

	Generating Sites						
	Ames, ANL-E, Bettis, BNL, Fermi, FEMP, KAPL, Mound, PORTS, PPPL, RMI, WVDP	Hanford, LBL, LLNL, SLAC	INEL, NTS	KCP, RFETS	LANL, Pantex, SNL-NM	ORR, PGDP	Pinellas, SRS
Treat (% Rec'd From Offsite)	PORTS (30)	Hanford (3)	INEL (<1)	RFETS (<1)	LANL (<1)	ORR (4)	SRS (<1)
Dispose (% Rec'd From Offsite)	NTS (99)						

Notes: All sites send minimum treatment wastes directly to NTS for disposal. Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3-13. LLW Centralized Alternative 4

LLW Centralized Alternative 5—(Treatment and Disposal at 1 Site)

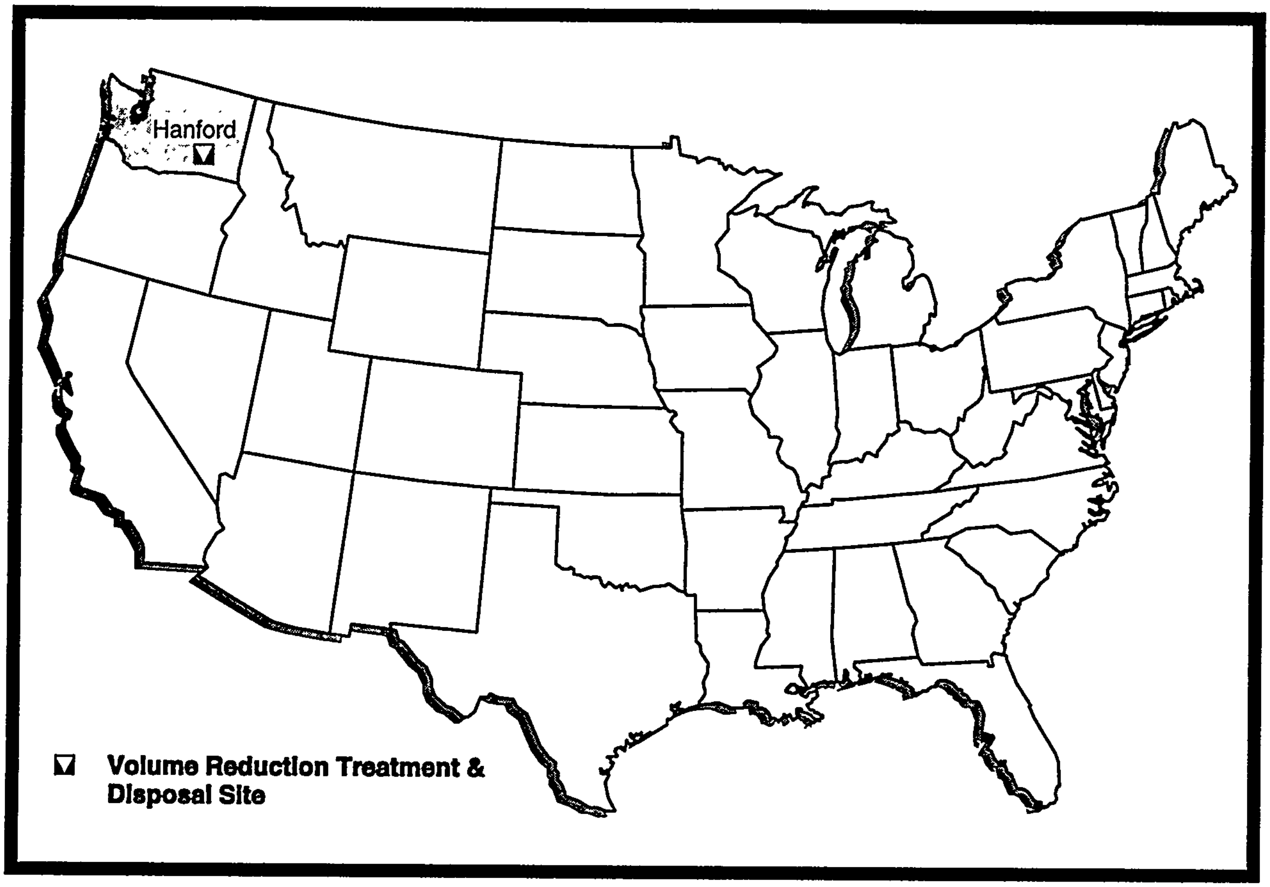


Figure 7.3–14. LLW Centralized Alternative 5

	Generating Sites All Sites
Treat (% Rec'd From Offsite)	Hanford (95)
Dispose (% Rec'd From Offsite)	Hanford (94)

Notes: All sites send minimum treatment waste to the Hanford Site for disposal. Alpha-LLW would be treated and disposed of at the closest of five sites: the Hanford Site, INEL, RFETS, LANL, and SRS. RH LLW would be treated and/or disposed of at one of four sites with RH facilities: the Hanford Site, INEL, ORR, and SRS. Percentage of waste a site would receive from offsite is indicated in parentheses.

Table 7.3–14. LLW Centralized Alternative 5

7.4 Health Risks

The greatest fatality risk is to waste management workers, primarily for physical hazards. The number of worker fatalities would decrease as the volume of LLW decreases through volume reduction. Radiation exposure risks to noninvolved worker and offsite populations are a function of the treatment technology and the DOE site. The highest risks to offsite populations would occur at FEMP, Hanford, LLNL, ORR, and Portsmouth as a result of volume reduction of tritium-contaminated waste at these sites. Concentrations of radionuclides in the groundwater near disposal facilities exceed applicable standards at several sites, demonstrating the need for performance based waste acceptance criteria. Management of radionuclide concentrations and waste forms would be required to assure acceptable water quality and human health risks. Transportation risks from both traffic accidents and radiation exposure would be greatest under the Centralized Alternatives, which involves the largest number of vehicle miles traveled.

Health risk impacts can result from exposure to radiation and from physical trauma associated with constructing and operating treatment and disposal facilities or transporting waste. Health effects resulting from radiation exposure, whether from sources external or internal to the body, can affect either the exposed individual's body (known as a "somatic" effect; e.g., cancer) or descendants of the exposed individual (known as a "genetic" effect). This section discusses the estimated adverse health impacts resulting from radiation exposures as well as from physical hazards for each LLW treatment and disposal alternative. Details of the LLW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5, Appendix D, and in ORNL technical reports (ORNL, 1995a-c).

The following sections present the impacts for the LLW Alternatives:

7.4 Health Risks
7.5 Air Quality Impacts
7.6 Water Resources Impacts
7.7 Ecological Resources Impacts
7.8 Economic Impacts
7.9 Population Impacts
7.10 Environmental Justice Concerns
7.11 Land Use Impacts
7.12 Infrastructure Impacts
7.13 Cultural Resources Impacts
7.14 Costs
7.15 Environmental Restoration Analysis
7.16 Comparison of Alternatives Summary

Potential health risks to a number of receptor populations and individuals are presented including:

- The offsite population—those individuals living within a 50-mile radius of the site, as well as along transportation routes
- Noninvolved worker population—the workers on DOE sites who are not involved directly in waste management activities

- Waste management worker population (or "waste management workers")—onsite employees working in a site's waste management facilities, including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste
- Maximally exposed individual (MEI) for the offsite population—hypothetical individual in the offsite population who would receive the highest total lifetime multimedia dose
- MEI for the noninvolved worker population—hypothetical individual in the noninvolved worker population who would receive the highest total lifetime multimedia dose
- Farm family most exposed lifetime MEI—hypothetical individual in the most exposed lifetime of the farm family who would receive the highest dose from disposal of LLW
- A hypothetical intruder—an individual who would experience maximum potential future risks from disposal of LLW upon the loss of institutional control

> ***Maximally Exposed Individual***
>
> *In keeping with the standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week, for the 10-year period of operations analyzed in the WM PEIS.*

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer fatalities from radiation exposure
- Cancer incidences from radiation exposure
- Genetic effects from radiation exposure

Interpreting the results of health risk analyses involves consideration of both uncertainties and appropriate standards. See Section 5.4.1 and Appendix D for a further discussion of these issues.

7.4.1 Routine Operation Impacts

7.4.1.1 Treatment

For operations involving LLW treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in LLW treatment ("noninvolved workers"), and waste management workers directly involved in treatment activities. Impacts were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented. Table 7.4–1 provides estimates of the sizes of the offsite and waste treatment worker populations by site. The waste management worker numbers are derived from generic baselines which established the number of personnel required to operate treatment facilities to manage a given amount of waste.

Individual impacts focus on the *probability* that the MEI within each receptor population would experience an adverse health impact. Because the focus is on the MEI, the risk is presented as a probability (e.g., one-in-one million or 1E–06) of that individual experiencing an adverse health impact, rather than a total number of impacts for a selected population.

DOE analyzed effects of LLW radionuclides on the receptor groups. The pathways of exposure analyzed were inhalation, ingestion of plants and animals, direct gamma radiation, and absorption of tritium through the skin.

Worker risks associated with physical hazards were evaluated for 20 years: a 10-year period of construction of treatment and disposal facilities, and a subsequent 10-year period of operation. However, worker and public risks from exposure to radionuclides (received during the 10-year operation period) were evaluated for an entire lifetime (70 years) because health impacts from airborne contaminants or direct radiation could occur throughout the lifetime of the exposed individual.

Understanding Scientific Notation

Scientific notation is used in this PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10
$10^{1} = 10 \times 1 = 10$
$10^{2} = 10 \times 10 = 100$
and so on, therefore,
$10^{6} = 1{,}000{,}000$ *(or 1 million)*
etc.

Negative Powers of 10
$10^{-1} = 1/10 = 0.1$
$10^{-2} = 1/100 = 0.01$
and so on, therefore,
$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.

A power of 10 is also commonly expressed as "E", where "E" means "× 10". For example, 3×10^{5} *can also be written as 3E+05, and* 3×10^{-5} *is equivalent to 3E–05. Therefore, 3E+05 = 300,000 and 3E–05 = 0.00003.*

The health risk data tables in this section use "E" notation with negative exponents.

Probability is expressed as a number between 0 and 1. The notation 3E–06 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., fatal cancer) will occur in the period covered by the analysis.

Table 7.4–2 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for LLW treatment.

7.4.1.2 Disposal

Health risks resulting from LLW disposal were evaluated for waste management workers handling the treated LLW, for an onsite "hypothetical farm family" located 300 meters from the center of the disposal facility, and for a hypothetical "intruder" into the disposal facility after the facility has been closed.

The waste management workers were assumed to be exposed through direct radiation during disposal operations. Risks to the waste management workers (resulting from the 10-year operation/exposure period) were estimated for one lifetime (70 years).

Table 7.4-1. Offsite Population and Waste Management Treatment Worker Populations by Site

Site	Offsite Population[a]	WM Treatment Worker Population by Alternative[b]													
		NA	D	R1	R2	R3	R4	R5	R6	R7	C1	C2	C3	C4	C5
ANL-E	7,939,785	402	224	224	224	224	224	224	224	224	224	224	224	224	224
BNL	5,738,554	695	273	417	417	417	417	417	417	417	417	417	417	197	417
FEMP	2,764,589	--	--	--	461	--	--	--	--	--	--	--	--	--	--
Hanford	377,645	997	577	577	1,569	577	1,634	1,634	577	843	577	843	1,634	1,634	9,856
INEL	153,061	2,169	677	677	1,809	677	1,809	3,954	1,032	1,032	1,032	1,032	1,809	1,809	677
LANL	159,152	920	653	653	1,362	653	2,731	902	902	902	902	902	2,731	2,731	902
LLNL	6,324,234	426	191	191	483	227	227	227	227	227	227	227	227	227	227
NTS	14,266	78	64	64	108	64	108	108	108	64	108	64	108	108	108
ORR	881,652	2,895	1,892	1,892	5,198	1,811	5,117	5,819	2,259	2,259	2,259	2,259	5,246	5,246	2,259
PGDP	500,502	654	501	501	800	503	497	497	503	503	503	503	497	497	497
Pantex	265,185	333	214	214	216	214	214	214	214	214	214	214	214	214	214
PORTS	639,602	1,450	730	730	3,434	1,075	3,483	1,087	1,075	1,075	1,075	1,075	3,481	3,481	1,087
RFETS	2,171,877	656	298	298	800	344	800	344	344	344	344	344	800	800	344
SNL-NM	610,714	277	187	210	210	210	210	210	210	210	210	210	232	232	210
SRS	620,618	3,032	1,986	1,986	2,598	1,986	2,598	2,598	1,986	1,986	2,008	2,008	2,598	2,598	1,986
WVDP	1,698,391	539	433	464	463	464	463	463	464	464	464	464	463	463	463

Notes: NA = No Action; D = Decentralized; R1-R7 = Regionalized; C1-C5 = Centralized. -- = no waste treatment at this site under this alternative.
[a] Within 50-mile radius of sites.
[b] Waste management worker population estimates represent full-time equivalents (FTEs) over the entire construction and operation period.

For the farm family and intruder analyses, DOE assumed that waste was disposed of in either aboveground or belowground disposal units, depending on the site, each with a capacity of 18,000 and 12,000 cubic meters, respectively. Additional units were added as needed to dispose all of the waste on a site. Each disposal unit was assumed to affect a separate farm family and a separate intruder. Thus, the effects on the farm family (and on the intruder) were assumed to come from a single disposal unit, rather than from a combination of all the units at a site.

The exposure pathways for the hypothetical farm family were ingestion of groundwater and ingestion of plants and animals contaminated by irrigation water. The groundwater was assumed to be contaminated by a breach in each disposal unit immediately after shallow land burial, 300 years after disposal in aboveground vaults, or 750 years after disposal in belowground vaults. The contaminants are assumed to leach over time from their solidified waste form to create a plume of contamination. Individual contaminant plumes were then assumed to migrate to the receptor wells without mixing with each other. The risks to

Table 7.4-2. LLW Treatment Health Risk Analysis Components

LLW Treatment					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of Physical Hazard Fatalities	WM Workers	Physical Hazards	Physical Hazards	20 years	7.4-4
Number of Cancer Fatalities	Offsite Population	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-4
	Noninvolved Workers		Inhalation, Direct Radiation		
	WM Workers		Inhalation, Direct Radiation		
Number of Cancer Incidences	Offsite Population	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-5
	Noninvolved Workers		Inhalation, Direct Radiation		
	WM Workers		Inhalation, Direct Radiation		
Number of Genetic Effects	Offsite Population	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-5
	Noninvolved Workers		Inhalation, Direct Radiation		
	WM Workers		Inhalation, Direct Radiation		
Probability of Cancer Fatality	Offsite MEI	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-6 7.4-7
	Noninvolved Worker MEI		Inhalation, Direct Radiation		7.4-6
Probability of Cancer Incidence	Offsite MEI	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-8
	Noninvolved Worker MEI		Inhalation, Direct Radiation		
Probability of Genetic Effects	Offsite MEI	Radionuclides	Inhalation, Ingestion, Direct Radiation	10 years	7.4-8
	Noninvolved Worker MEI		Inhalation, Direct Radiation		

the hypothetical farm family were estimated over a 10,000-year period because the maximum exposure would occur in the future when the peak of contaminant concentration passes the well. The 10,000-year period was selected for the analysis to maintain consistency with the "Guidelines for Radiological Performance Assessment: DOE Low-Level Radioactive Waste Disposal Sites" that existed at the time the WM PEIS analysis was initiated. The guidance for performance assessments has since been changed; current guidance suggests that a 1,000-year time period should be used in the performance assessments for waste disposal conducted to satisfy the requirements of DOE Order 5820.2A. Results of the farm family analyses are presented as the probability of cancer fatality for an individual during the 70-year lifetime that presents the greatest exposure of the 143 lifetimes (i.e., 10,000 years) analyzed.

The exposure pathways for the hypothetical intruder were inhalation of resuspended contaminated soil, inadvertent ingestion of contaminated soil, ingestion of plants grown in contaminated soil, direct radiation from contaminated soil, and absorption of tritium through the skin. A hypothetical intruder who drills into the disposal unit was assumed to be exposed to radioactively contaminated wastes that remain at the site. Two hypothetical intrusions were assumed to occur: 100 years and 300 years after closure of the disposal unit. The risks to the hypothetical intruder were estimated for one lifetime (70 years).

Hypothetical Farm Family and Intruder

The "hypothetical farm family" is an imaginary family assumed to live 300 meters downgradient of the center of a waste disposal unit. The family engages in farming activities such as growing and consuming their own crops and livestock, and uses groundwater for watering the crops and animals. This is an estimated maximum scenario taking place in the future at a time when institutional controls no longer exist. The scenario is analyzed to determine potential upper-bound exposures by ingestion of contaminated groundwater.

The hypothetical "intruder" is an imaginary adult who drills a well directly through a LLW disposal unit to the groundwater. As a result of the drilling, radioactively contaminated soil from within the unit is brought to the surface, where it mixes with the top layers of the surface soil. The individual farms the land and eats the crops. The intruder scenario occurs after the failure of institutional control. This is consistent with the analysis required for disposal facilities under DOE Order 5820.2A (DOE, 1988).

Table 7.4–3 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for LLW disposal.

The health risk impacts associated with the routine operation of LLW treatment and disposal facilities are presented in Tables 7.4–4 through 7.4–13 of this section. The tables show the estimates of human health risk for both treatment and disposal of LLW. Summary tables show programwide results by alternative. The site tables in Volume II present the health impacts for the 16 major LLW sites.

This human health risk analysis includes evaluation of both the potential numbers of fatal cancers as well as the numbers of total cancer incidences induced by exposure to radionuclides and direct radiation. The numbers of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases. Note that both the *total cancer incidence* and the *nonfatal cancer incidence* values are overestimated by a factor of about two because the estimates contain a relatively large component

Table 7.4–3. LLW Disposal Health Risk Analysis Components

LLW Disposal					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of Physical Hazard Fatalities	WM Workers	Physical Hazards	Physical Hazards	20 years	7.4–4
Number of Cancer Fatalities	WM Workers	Radionuclides	Direct Radiation	10 years	7.4–4
Number of Cancer Incidences	WM Workers	Radionuclides	Direct Radiation	10 years	7.4–5
Number of Genetic Effects	WM Workers	Radionuclides	Direct Radiation	10 years	7.4–5
Probability of Cancer Fatality	Hypothetical Farm Family Most Exposed Lifetime MEI	Radionuclides	Ingestion	70 years	7.4–9
	Hypothetical Intruder		Inhalation, Ingestion, and Direct Radiation		7.4–12 7.4–13
Probability of Cancer Incidence	Hypothetical Intruder	Radionuclides	Inhalation, Ingestion, Direct Radiation	70 years	7.4–12
Probability of Genetic Effects	Hypothetical Intruder	Radionuclides	Inhalation, Ingestion, Direct Radiation	70 years	7.4–12

of skin cancers. The internal exposure pathways evaluated in this PEIS (e.g., inhalation or ingestion of radionuclides) are not likely to induce large numbers of skin cancer cases. However, the International Commission on Radiological Protection (ICRP) dose conversion factor used in the WM PEIS to estimate total cancer incidence includes incidences of skin cancer (ICRP, 1990).

7.4.1.3 Estimated Number of Fatalities

7.4.1.3.1 Programwide

Table 7.4–4 presents an overview, by alternative, of the total estimated programwide fatalities associated with both treatment and disposal of LLW. This table presents the estimated number of latent cancer fatalities

Table 7.4-4. LLW Treatment and Disposal: Estimated Number of Fatalities Programwide

Alternative	Number of Sites		Treatment				Disposal	
			WM Workers				WM Workers	
	T[a]	D	Number of Radiation Cancer Fatalities	Number of Physical Hazard Fatalities	Number of Offsite Population Radiation Cancer Fatalities	Number of Noninvolved Worker Radiation Cancer Fatalities	Number of Radiation Cancer Fatalities	Number of Physical Hazard Fatalities
No Action	10[b]	6	1	3	*	*	3	4
Decentralized		16	1	2	*	*	2	6
Regionalized 1		12	1	2	*	*	3	6
Regionalized 2	11	12	1	4	1	*	2	4
Regionalized 3		6	1	2	*	*	3	5
Regionalized 4	7	6	2	4	*	*	2	4
Regionalized 5	4	6	2	4	*	*	2	4
Regionalized 6		2	1	2	*	*	2	6
Regionalized 7		2	1	2	*	*	1	6
Centralized 1		1	1	2	*	*	3	1
Centralized 2		1	1	2	*	*	2	1
Centralized 3	7	1	1	4	*	*	2	1
Centralized 4	7	1	1	4	*	*	2	*
Centralized 5	1	1	2	4	*	*	2	1

Notes: T = treatment; D = disposal. * = greater than 0 but less than 0.5.
[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum
treatment occurs, the cells are left blank.
[b] Ten sites use existing facilities for volume reduction.

in the offsite population, noninvolved workers, and waste management workers caused by radiological exposure. In addition, the table shows the estimated number of waste management worker deaths resulting from physical hazards during facility construction and operation.

For each alternative, there are at least three estimated fatalities associated with treatment operations. These fatalities occur primarily within the waste management worker population, and result mainly from physical hazards involved in construction and operation of LLW treatment facilities. Waste management workers are the only receptor group exposed to these physical hazards, and therefore, have more estimated fatalities than other receptor groups. A single fatality in the offsite population is estimated under Regionalized Alternative 2; no fatalities are estimated in the noninvolved worker population under any treatment alternative. In general, alternatives involving volume reduction present greater treatment risks to workers than alternatives involving only minimum treatment.

Disposal operations show at least six estimated fatalities to waste management workers in all alternatives, except where disposal is consolidated at one site. Waste management worker disposal radiation cancer fatalities are generally greater than those estimated for treatment. Under the single disposal site alternatives, the number of physical hazard fatalities decreases, whereas cancer fatalities from radiation exposure are similar to those estimated for the other disposal alternatives.

For all alternatives, the estimated number of fatalities to waste management workers due to physical hazards exceeds estimated radiological fatalities to the offsite and noninvolved worker populations. In general, risk to waste management workers appears to decrease with increased centralization of disposal activities. Fewer fatalities from physical hazards occur because fewer facilities and worker hours are required when waste management activities are consolidated at one or a few sites.

7.4.1.3.2 Site-Level

At least one fatality resulting from physical hazards or radiation exposure associated with implementing the LLW alternatives is estimated to occur at seven sites: the Hanford Site, NTS, INEL, LANL, ORR, PORTS, and SRS. All of these fatalities are estimated to occur within the waste management worker population, primarily as a result of physical hazards during treatment or disposal activities. Although fewer in number, fatalities due to radiation exposure of waste management workers during treatment and disposal are estimated to occur at the Hanford Site and NTS.

Each of the LLW alternatives results in at least one site with one or more estimated fatalities. Under Regionalized Alternatives 2, 4, 5, 6 and 7 and Centralized Alternatives 3 and 4, at least two of the above sites have estimated waste management worker fatalities exceeding one.

7.4.1.4 Estimated Number of Cancer Incidences and Genetic Effects

7.4.1.4.1 Programwide

Table 7.4–5 presents an overview, by alternative, of the total number of programwide cancers and genetic effects associated with treatment and disposal of LLW. These impacts result from radiation exposure of the offsite population (treatment-related only), noninvolved workers (treatment-related only), and waste management workers (treatment and disposal). In addition, the table includes radiation dose estimates for each receptor group.

Each of the treatment alternatives results in at least three cancer incidences in the waste management workers. Cancer incidence in the other receptor groups is limited to an estimated two cancers in the offsite population under Regionalized Alternative 2 and one cancer incidence under Regionalized Alternative 5. The number of genetic effects was not estimated to equal or exceed one in any receptor group.

At least six radiation-induced cancers among the waste management workers were estimated under each of the disposal alternatives. The volume reduction alternatives (Regionalized 2, 4, and 5 and Centralized 3, 4, and 5) generally had lower estimated numbers of cancers.

7.4.1.4.2 Site-Level

At least one latent cancer incidence resulting from radiation exposure associated with implementation of the LLW alternatives is estimated to occur at seven sites: the Hanford Site, INEL, LANL, LLNL, NTS, ORR, and SRS.

Table 7.4-5. LLW Treatment and Disposal: Estimated Number of Cancer Incidences and Genetic Effects Programwide

			Treatment									Disposal		
			Offsite Population			Noninvolved Workers			WM Workers			WM Workers		
	Number of Sites													
Alternative	T[a]	D	Radiation Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10[b]	6	5	*	*	*	*	*	2,900	4	*	8,000	11	*
Decentralized		16	58	*	*	*	*	*	1,900	3	*	5,600	8	*
Regionalized 1		12	58	*	*	*	*	*	2,000	3	*	6,100	9	*
Regionalized 2	11	12	1,300	2	*	13	*	*	3,200	5	*	4,900	7	*
Regionalized 3		6	58	*	*	*	*	*	2,000	3	*	6,900	10	*
Regionalized 4	7	6	200	*	*	4	*	*	3,600	5	*	5,300	7	*
Regionalized 5	4	6	750	1	*	10	*	*	4,200	6	*	5,300	7	*
Regionalized 6		2	58	*	*	*	*	*	2,100	3	*	4,400	6	*
Regionalized 7		2	58	*	*	*	*	*	2,100	3	*	3,500	5	*
Centralized 1		1	58	*	*	*	*	*	2,100	3	*	6,900	10	*
Centralized 2		1	58	*	*	*	*	*	2,100	3	*	5,500	8	*
Centralized 3	7	1	200	*	*	4	*	*	3,600	5	*	4,400	6	*
Centralized 4	7	1	200	*	*	4	*	*	3,600	5	*	3,900	6	*
Centralized 5	1	1	200	*	*	2	*	*	5,500	8	*	4,400	6	*

Notes: T = treatment; D = disposal. * = greater than 0 but less than 0.5.
[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.
[b] Ten sites use existing facilities for volume reduction.

At all of these sites except LLNL and ORR, waste management workers are the only receptor group with cancer incidence equal to or greater than one. At LLNL, the cancer incidence is estimated to occur within the offsite population under Regionalized Alternative 2 as a result of exposure to tritium. At ORR, the cancer incidence is estimated to occur within the offsite population under Regionalized Alternative 5 as a result of exposure to tritium. No sites are estimated to have one or more genetic effects.

7.4.1.5 Probability of MEI Cancer Fatalities

Table 7.4–6 summarizes, by alternative, the highest estimated *probability* at any site of fatal cancer from exposure to radiation associated with each LLW alternative. This table presents the probability of cancer fatality to the MEIs within the offsite and noninvolved worker populations. The numbers in this table are the estimated *probabilities* that the MEI will die of latent cancer from radiation exposure.

The probability of a cancer fatality for the MEI was calculated at each site, and the highest value at a single site under each alternative is presented in Table 7.4–6. The MEI risk is not a combined total of risks across all of the sites.

The volume reduction alternatives generally have cancer fatality probability values that are about one order of magnitude higher than the values in other alternatives for the offsite MEI and about one to two orders of magnitude higher than the values in the other alternatives for the noninvolved worker MEI.

Table 7.4–7 presents the probability of a latent cancer fatality from radiological exposure for the offsite MEI for all sites by treatment alternative. The data in Table 7.4–7 are graphically presented in Figure 7.4–1. The highest cancer fatality probabilities are found at FEMP, the Hanford Site, LLNL, ORR, and Portsmouth. The radionuclide contaminant released during treatment operations that drives the cancer risk at each of these sites is tritium.

7.4.1.6 Probability of MEI Cancer Incidence and Genetic Effects

Table 7.4–8 summarizes, by alternative, the highest estimated *probability* at any site of cancer incidences and genetic effects resulting from radiation exposure. This table presents these estimated risks for the MEIs within the offsite and the noninvolved worker populations.

Table 7.4-6. LLW Treatment: Greatest Probability of Cancer at Any LLW Site

Alternative	Number of Sites		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
	T[a]	D		
No Action	10[b]	6	2E-08	3E-08
Decentralized		16	2E-07	5E-08
Regionalized 1		12	2E-07	5E-08
Regionalized 2	11	12	6E-06	2E-06
Regionalized 3		6	2E-07	5E-08
Regionalized 4	7	6	2E-06	9E-07
Regionalized 5	4	6	9E-06	4E-06
Regionalized 6		2	2E-07	5E-08
Regionalized 7		2	2E-07	5E-08
Centralized 1		1	2E-07	5E-08
Centralized 2		1	2E-07	5E-08
Centralized 3	7	1	2E-06	6E-07
Centralized 4	7	1	2E-06	6E-07
Centralized 5	1	1	2E-06	2E-06

T = treatment; D = disposal. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.
[b] Ten sites use existing facilities for volume reduction.

Table 7.4-8 indicates that the highest radiation cancer incidence probability for the offsite MEI is found under Regionalized Alternative 5. Cancer incidence probabilities generally are 5–20 times higher for the volume reduction alternatives than for the minimum treatment alternatives. A similar trend can be seen in the cancer incidence probabilities for the noninvolved worker MEI.

Offsite MEI radiation cancer incidence probability is highest for alternatives involving Regionalized or Centralized volume reduction, including thermal treatment. Highest values are at FEMP (under Regionalized Alternative 2), the Hanford Site (under Regionalized Alternatives 4 and 5 and Centralized Alternatives 3, 4, and 5), LANL (under Regionalized Alternatives 2 and 4 and Centralized Alternatives 3 and 4), LLNL (under Regionalized Alternative 2), ORR (under Regionalized Alternative 5), and at

Table 7.4–7. LLW Treatment: Offsite MEI Cancer Fatality Probabilities

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP[c]
	T[a]	D																
No Action	10[b]	6	1E–11	3E-11	--	9E–12	2E–10	2E–08	6E–12	~0	1E–10	2E–12	8E–11	2E–13	2E–12	7E–11	6E–09	5E–11
Decentralized		16	1E–11	1E–13	--	6E–11	1E–10	2E–08	2E–07	~0	2E–10	4E–11	4E–11	3E–14	5E–12	7E–11	2E–10	2E–11
Regionalized 1		12	1E–11	3E-11	--	6E–11	1E–10	2E–08	2E–07	~0	2E–10	4E–11	4E-11	3E–14	5E–12	7E–11	2E–10	3E-11
Regionalized 2	11	12	1E–11	3E-11	4E–06	7E–11	2E–10	8E–07	6E–06	~0	3E–09	4E–11	4E-11	7E–09	3E–09	7E–11	6E–09	3E-11
Regionalized 3		6	1E–11	3E-11	--	6E–11	1E–10	2E–08	2E–07	~0	2E–10	2E–10	4E-11	2E–13	5E–12	7E–11	2E–10	3E-11
Regionalized 4	7	6	1E–11	3E-11	--	1E–06	2E–10	8E–07	7E–08	~0	3E–09	2E–12	4E-11	2E–06	3E–09	7E–11	6E–09	3E-11
Regionalized 5	4	6	1E–11	3E-11	--	1E–06	5E–09	2E–08	7E–08	~0	9E–06	2E–12	4E-11	2E–13	5E–12	7E–11	6E–09	3E-11
Regionalized 6		2	1E–11	3E-11	--	6E–11	2E–10	2E–08	2E–07	~0	4E–10	2E–12	4E-11	2E–13	5E–12	7E–11	2E–10	3E-11
Regionalized 7		2	1E–11	3E-11	--	9E–11	2E–10	2E–08	2E–07	~0	4E–10	2E–12	4E-11	2E–13	5E–12	7E–11	2E–10	3E-11
Centralized 1		1	1E–11	3E-11	--	6E–11	2E–10	2E–08	2E–07	~0	4E–10	2E–12	4E-11	2E–13	5E–12	7E–11	2E–10	3E-11
Centralized 2		1	1E–11	3E-11	--	9E–11	2E–10	2E–08	2E–07	~0	4E–10	2E–12	4E-11	2E–13	5E–12	7E–11	2E–10	3E-11
Centralized 3	7	1	1E–11	3E-11	--	1E–06	2E–10	8E–07	7E–08	~0	3E–09	2E–12	4E-11	2E–06	3E–09	7E–11	6E–09	3E-11
Centralized 4	7	1	1E–11	3E-11	--	1E–06	2E–10	8E–07	7E–08	~0	3E–09	2E–12	4E-11	2E–06	3E–09	7E–11	6E–09	3E-11
Centralized 5	1	1	1E–11	3E-11	--	2E–06	1E–10	2E–08	7E–08	~0	4E–10	2E–12	4E-11	2E–13	5E–12	7E–11	1E–10	3E-11

Notes: T = treatment; D = disposal; -- = action not applicable for the alternative. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.
[b] Ten sites use existing facilities for volume reduction.
[c] No waste reported for WVDP.

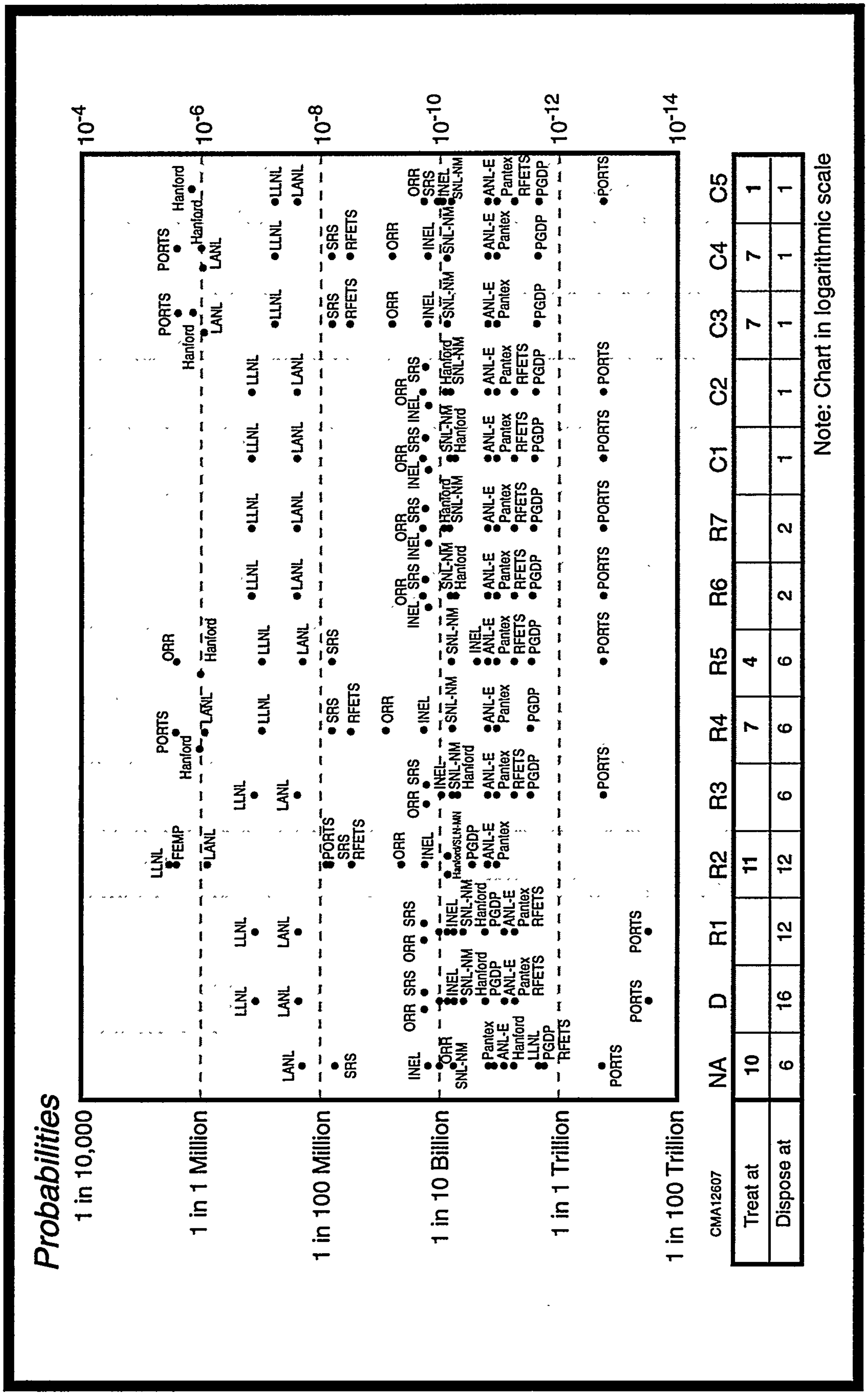


Figure 7.4-1. LLW Treatment: Probability of Cancer Fatality to Offsite MEI

Table 7.4–8. LLW Treatment: Greatest Probability of Cancer Incidences and Genetic Effects at Any LLW Site

Alternative	Number of Sites		Offsite MEI			Noninvolved Worker MEI		
	T[a]	D	Radiation Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Radiation Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10[b]	6	4E–05	7E–08	4E–09	6E–05	1E–07	6E–09
Decentralized		16	6E–04	1E–06	6E–08	9E–05	2E–07	9E–09
Regionalized 1		12	6E–04	1E–06	6E–08	9E–05	2E–07	9E–09
Regionalized 2	11	12	1E–02	2E–05	1E–06	4E–03	6E–06	4E–07
Regionalized 3		6	6E–04	1E–06	6E–08	9E–05	2E–07	9E–09
Regionalized 4	7	6	5E–03	8E–06	5E–07	2E–03	3E–06	2E–07
Regionalized 5	4	6	2E–02	3E–05	2E–06	8E–03	1E–05	8E–07
Regionalized 6		2	6E–04	1E–06	6E–08	9E–05	2E–07	1E–08
Regionalized 7		2	6E–04	1E–06	6E–08	9E–05	2E–07	9E–09
Centralized 1		1	6E–04	1E–06	6E–08	9E–05	2E–07	1E–08
Centralized 2		1	6E–04	1E–06	6E–08	1E–04	2E–07	1E–08
Centralized 3	7	1	5E–03	8E–06	5E–07	1E–03	2E–06	1E–07
Centralized 4	7	1	5E–03	8E–06	5E–07	1E–03	2E–06	1E–07
Centralized 5	1	1	3E–03	5E–06	3E–07	3E–03	6E–06	3E–07

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.0005. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction.

Portsmouth (under Centralized Alternatives 3 and 4). Tritium is the radionuclide that accounts for most of the risk at FEMP, the Hanford Site, LLNL, ORR, and Portsmouth, whereas uranium-238 (U-238) accounts for most of the risk at LANL. More recent estimates show potential increased air releases of tritium at FEMP, Hanford, and Portsmouth and U-238 at LANL (see Appendix I). Genetic effects incidence probability for the offsite MEI is highest at LLNL under Regionalized Alternative 2 as a result of exposure to tritium released during treatment of LLW. Cancer incidence probabilities for the noninvolved worker MEI are highest at FEMP, the Hanford Site, LANL, LLNL, ORR, and Portsmouth.

7.4.1.7 Hypothetical Farm Family Risk

In addition to the disposal risks to workers, already presented, disposal risks were evaluated using hypothetical receptors—a farm family and an intruder—as defined in Section 7.4.1. Risks to both the hypothetical farm family and the hypothetical intruder (Section 7.4.1.9) were analyzed in keeping with the requirements of DOE Order 5820.2A, "Radioactive Waste Management" (DOE, 1988). This order requires that site-specific performance assessments be conducted in order to demonstrate that a given disposal practice is in compliance with the set of performance objectives quantified in the DOE Order. These objectives specify concentrations and dose limits that are intended to be protective of the general public, an inadvertent intruder, and groundwater resources. Releases from the disposal facility occur as the result of natural causes (e.g., through leaching upon breakdown of the facility) and by inadvertent human intrusion.

The farm family scenario generically addresses potential contamination of groundwater resources as well as the potential health effect consequences of exposure of the general public to radionuclides released from the disposal facility. The radionuclides are assumed to leach from the disposal site through the unsaturated zone to contaminate groundwater that is used by a future farm family as a source of drinking water and irrigation water. See Section 5.4.1 for a further discussion of the presentation of farm family risk results.

Although the disposal facility risk analysis conducted in this WM PEIS uses scenarios that are similar to those used in the performance assessment process, it is important to note that the objectives of the two types of analysis are different. The WM PEIS hypothetical farm family and intruder scenario analyses assume the use of generic disposal facilities and generic waste forms (e.g., grout or polymers), and that the entire inventory of waste will be disposed (i.e., no exclusion of particular radionuclides). These assumptions lead to overestimates of contaminant concentration in groundwater. The objective of the WM PEIS analyses is to provide a relative comparison of potential risk among LLW management alternatives. The outputs of the analyses are risk estimates for the hypothetical farm family and intruder.

In contrast, the performance assessment analysis process involves the use of more detailed site-specific data in the design of a disposal facility at a particular location on a site. The objective of the analysis is to design a facility that will satisfy the performance objectives specified in DOE Order 5820.2A (DOE, 1988). In practice, implementation of this latter requirement may involve: (1) modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase adsorption or a concrete cap to reduce infiltration); (2) modifying the form of the waste to be disposed (such as changing to a vitrified waste form); (3) changing the specific location of the waste disposal facility so that it is sited over an area with more favorable hydrologic conditions; and (4) imposing waste acceptance criteria (i.e., restricting the amounts of radionuclides allowed in a given waste disposal facility). The output of the analysis is a set of waste disposal facility design criteria.

As a result of these differences, the WM PEIS analyses produce estimates of groundwater contamination and farm family risk that are higher than those that would be expected upon actual implementation of the LLW disposal alternatives. For example, the generic WM PEIS analysis estimates that radionuclide groundwater contamination will exceed existing drinking water quality protection standards at certain sites (see Section 7.6.2). However, the groundwater resource protection objectives contained in DOE Order 5820.2A would require that the waste disposal facility designs developed by the performance assessment analyses subsequently conducted at those sites ensure that drinking water standards would not be exceeded upon disposal of LLW. Consequently, the hypothetical farm family risk estimates presented in this section have been adjusted to reflect groundwater contamination that does not exceed existing standards. That is, radionuclides whose estimated groundwater concentrations exceeded drinking water standards were adjusted to concentrations that represent 100% of existing standards. The unadjusted risk estimates from the WM PEIS analysis are presented in the Volume II site tables and in Appendix D.

MEI cancer fatality probability estimates for each site that disposes LLW under the various alternatives are presented in Table 7.4–9. The results of the WM PEIS analysis indicate that disposal of uranium-238 (U-238) must be carefully controlled at the Hanford Site (under all alternatives), SNL-NM (under the Decentralized Alternative), and SRS (under all alternatives except Regionalized 6 and 7). More recent estimates show potential increased release of U-238 to the groundwater at Hanford and SRS (see Appendix I). Requisite controls are likely to result in additional costs and potentially to increased impacts in other resources areas. If the amount or form of U-238 is not controlled as previously described, the groundwater concentrations of the radionuclide at these sites are estimated to exceed drinking water standards. These elevated groundwater concentrations would produce cancer fatality probability estimates that are about an order of magnitude higher than those presented in Table 7.4–9 at SRS, one to two orders of magnitude higher at the Hanford Site, and more than two orders of magnitude higher at SNL-NM (see Volume II site tables and Appendix D). In a similar manner, the disposal of neptunium-237 (Np-237) would require careful control at Paducah (under the Decentralized and Regionalized Alternatives 1 and 2).

Table 7.4-9. LLW Disposal: Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probabilities

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T[a]	D																
No Action	10[b]	6	--	--	--	4E-05[c]	~0	~0	--	~0	2E-07	--	--	--	--	--	4E-06[c]	--
Decentralized		16	3E-05	5E-04	--	4E-05[c]	~0	~0	1E-06	~0	2E-07	8E-05[c]	~0	6E-08	3E-08	5E-05[c]	4E-06[c]	1E-04
Regionalized 1		12	--	--	--	4E-05[c]	~0	~0	1E-06	~0	2E-07	8E-05[c]	~0	5E-07	3E-08	--	4E-06[c]	--
Regionalized 2	11	12	--	--	--	4E-05[c]	~0	~0	1E-06	~0	4E-07	8E-05[c]	~0	9E-07	8E-08	--	4E-06[c]	--
Regionalized 3		6	--	--	--	4E-05[c]	~0	~0	--	~0	1E-07	--	--	--	--	--	4E-06[c]	--
Regionalized 4	7	6	--	--	--	4E-05[c]	~0	~0	--	~0	2E-07	--	--	--	--	--	4E-06[c]	--
Regionalized 5	4	6	--	--	--	4E-05[c]	~0	~0	--	~0	2E-07	--	--	--	--	--	4E-06[c]	--
Regionalized 6		2	--	--	--	4E-05[c]	--	--	--	--	--	--	--	--	--	--	9E-06	--
Regionalized 7		2	--	--	--	--	--	--	--	~0	--	--	--	--	--	--	9E-06	--
Centralized 1		1	--	--	--	4E-05[c]	--	--	--	--	--	--	--	--	--	--	--	--
Centralized 2		1	--	--	--	--	--	--	--	~0	--	--	--	--	--	--	--	--
Centralized 3	7	1	--	--	--	4E-05[c]	--	--	--	--	--	--	--	--	--	--	--	--
Centralized 4	7	1	--	--	--	--	--	--	--	~0	--	--	--	--	--	--	--	--
Centralized 5	1	1	--	--	--	4E-05[c]	--	--	--	--	--	--	--	--	--	--	--	--

Notes: T = treatment; D = disposal; -- = action not applicable for alternative. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those sites or alternatives where only minimum treatment occurs, the cells are left blank.
[b] Ten sites use existing facilities for volume reduction.
[c] These are adjusted values. They represent the estimated risks when groundwater concentrations of radionuclides are adjusted to 100% of existing standards. Radionuclides that drive risks and exceed groundwater standards include uranium-238 at the Hanford Site, SRS, and SNL-NM and neptunium-237 at Paducah. Unadjusted risk estimates are presented in the Volume II site data tables and in Appendix D.

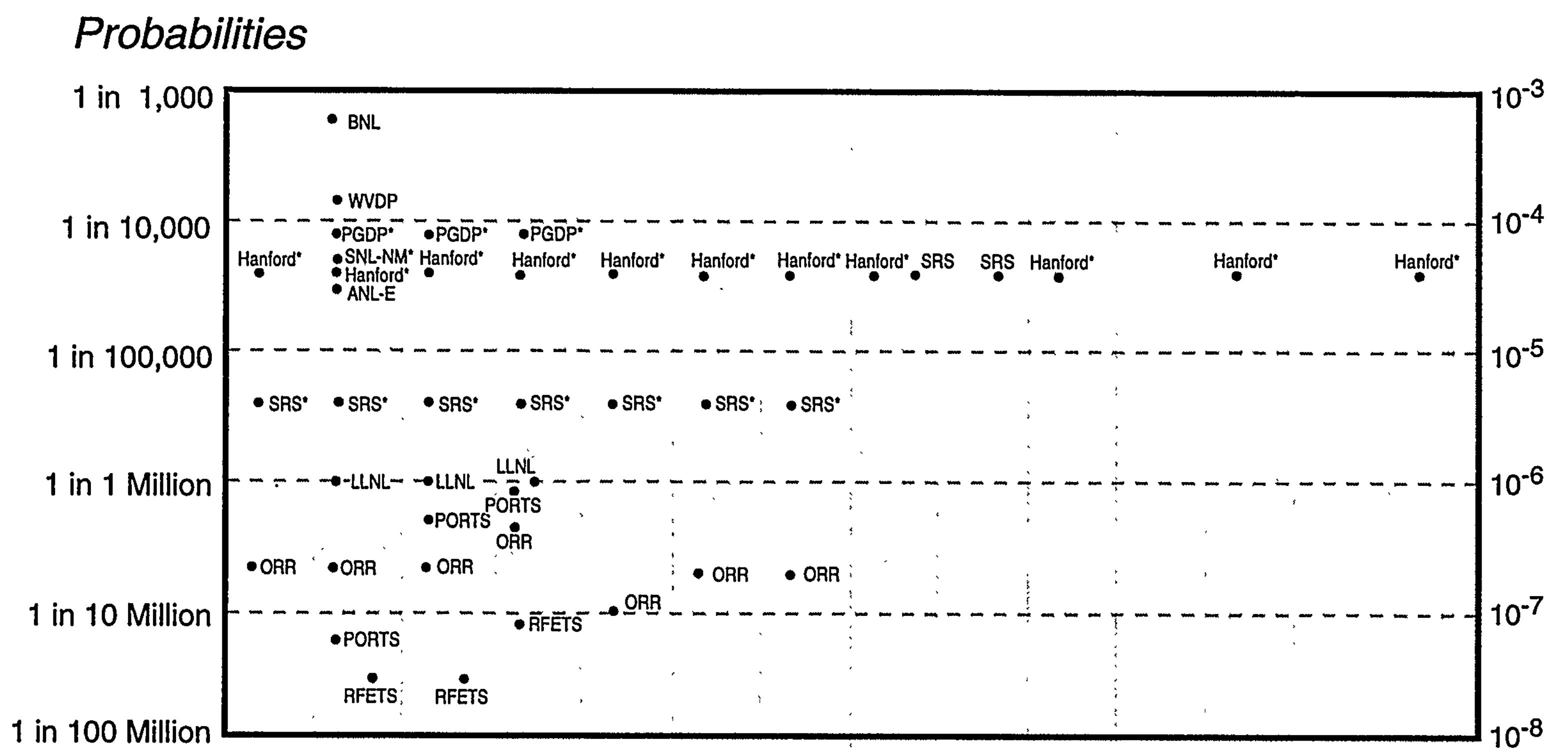
The estimated times of maximum future radionuclide exposure at these sites are as follows:

- The Hanford Site—U-238 at 1,260 years
- SNL-NM—U-238 at 1,050 years
- SRS—U-238 at 11,460 years
- Paducah—Np-237 at 3,240 years

In addition, although groundwater concentrations of radionuclide contaminants are not estimated to exceed drinking water standards, the estimated cancer fatality probabilities at BNL and WVDP under the Decentralized Alternative are high. Technetium-99 is the contaminant that accounts for most of the risk at BNL, whereas neptunium-237 drives the estimated farm family risk at WVDP.

The results of this analysis, graphically presented in Figure 7.4–2, also indicate that, on the basis of estimated MEI cancer fatality probability, disposal of LLW at ANL-E, INEL, LANL, LLNL, NTS, ORR, the Pantex Plant, PORTS, and RFETS could be accomplished for the WM PEIS-assumed wastes without additional radionuclide constraints. Of these sites, INEL, LANL, NTS, and the Pantex Plant had the lowest (zero) estimated cancer fatality probabilities.

The hypothetical farm family risks represent individual receptors assumed to be exposed through location of a drinking water well at 300 m from the center of a single disposal unit. Concentrations of groundwater contaminants at this location are assumed to be higher than those that could be expected at greater distances from the unit due to dispersion of contaminants. Construction of multiple units is expected to be required to dispose of the projected waste volumes at certain sites under the various LLW alternatives. Although the farm family scenario evaluates only a single receptor 300 m from an individual unit, DOE assumes that each of these close-in receptors will be affected primarily by the contaminant plume from the closest facility. DOE recognizes that commingling of contaminant plumes from multiple disposal units may occur as distance from the units increases but anticipates that, at 300 m, the highest concentration of contaminants is likely to result from the single closest plume. At greater distances from the disposal units, where overlap of the plumes is more likely, the concentrations in any given plume should be lower than those estimated at the 300-m well as a result of dispersion and dilution. However, the WM PEIS cannot address groundwater contaminant concentrations at distances greater than 300 meters from disposal units. More detailed analyses, such as the performance assessments required under DOE Order 5820.2A, will address the issues of existing groundwater contamination and multiple disposal units. For example, in April 1996, DOE issued guidance for the conduct of composite analyses in addition to performance assessments to help



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	NA	D	R1	R2	R3	R4	R5	R6	R7	C1	C2	C3	C4	C5
Treat at	36			11		7	4					7	7	1
Dispose at	6	16	12	12	6	6	6	2	2	1	1	1	1	1

*Adjusted values - see text discussion

Note: Chart in logarithmic scale

Figure 7.4–2. LLW Disposal: Probability of Cancer Fatality to Hypothetical Farm Family Most Exposed Lifetime MEI ensure that continuing disposal of LLW will not compromise the future radiological protection of the public. A composite analysis will estimate the potential cumulative impacts to a hypothetical future member of the public from an active or planned LLW disposal facility and other sources of radioactive material in the ground that might interact with the LLW disposal facility.

7.4.1.8 Potential Collective Risk to Offsite Population From Waste Disposal

Risk assessments generally evaluate both collective and individual health risks, that is, risks for both populations of receptors and for MEIs. However, the WM PEIS disposal risk analysis quantitatively estimates risks only for the farm family MEI. Although the farm family scenario disposal risk analysis uses site-specific hydrogeologic and meteorologic data, use of "conceptual" disposal units was assumed. The analysis did not attempt to identify exact locations of these generic units on a site; rather, they were assumed to be placed either near existing disposal units where such units existed, or at a location on the site expected to be most sensitive to groundwater contamination. Since the analysis does not attempt to actually locate the disposal units on the site, DOE believes it is not possible to develop plausible quantitative estimates of the collective risks to current or future offsite populations resulting from exposure to contaminated groundwater. Both the concentrations of contaminants in the groundwater and the number of people potentially exposed will be strongly influenced by the locations of the disposal units and receptor wells. A hypothetical siting decision to support such an analysis is not favored because the choice of a site so strongly influences the results as to make them a direct reflection of the choice.

To address the relative potential of the proposed disposal sites and alternatives for collective risk to offsite populations, values for site parameters that are expected to influence potential groundwater contamination or that are associated with the relative size of populations at risk were statistically analyzed. These variables included the size of the site (acres), depth to aquifer, size of offsite population living within 50 miles of the site, annual rainfall, natural recharge rate, and time of travel of groundwater from the surface to a downgradient well. Statistical analysis of these variables produced clusters or groupings of sites according to their relative potential risk vulnerability. These groupings are believed to be more appropriate metrics for decision making, given the lack of facility siting and other relevant information, than quantitative estimates of person-rem doses and latent cancer fatalities.

Section C.4.1 of Appendix C contains additional information about the methodology and results of the offsite population risk vulnerability analysis. This section also describes other DOE efforts to assess potential risks from waste disposal, including those of the Federal Facility Compliance Act Disposal Workgroup and the performance assessment process required by DOE Order 5820.2A.

Section 5.4.1 of Chapter 5 contains a discussion of the results of the collective risk vulnerability analysis. The sites are grouped into three population risk vulnerability (PRV) roups, with Group 1 having the lowest potential vulnerability for offsite population risks from groundwater contamination following LLW disposal, and Group 3 having the highest potential. It is important to note that this is a screening-level analysis that does not take into account any measures that would limit migration of disposed wastes into the groundwater, such as engineered disposal units or changes in waste acceptance criteria. The objective of the analysis is not to rule out any sites for disposal—a number of sites are currently disposing LLW—but to indicate where such disposal mitigation measures are more likely to be necessary and where the costs of disposal would likely increase as a result. In particular, though some sites may be listed in Group 3, this does not mean that disposal would be unacceptable there. Rather, it means that mitigation would be an important part of a disposal plan for these sites.

As previously described, the waste volume, total radioactivity, and number of potential disposal units required at a given site varies by waste management alternative. Table 7.4–10 presents data on disposal volumes, number of disposal units, and curies for each site as they vary over the proposed alternatives, in conjunction with the results of the population risk vulnerability factor and cluster analyses. This information is summarized by risk vulnerability cluster for each alternative and is displayed in Table 7.4–11. The summary data in Table 7.4–11 suggest that the Centralized Alternatives present lower potential collective risks to offsite populations from disposal than the Decentralized or Regionalized Alternatives.

Note that the results of this screening-level risk vulnerability analysis are useful in discussing the relative potentials among the sites and the proposed waste management alternatives. However, more refined risk analyses will be included in the site-specific performance assessments that will be conducted for the design and siting of new disposal facilities. In addition, DOE will consider a number of other factors in the development of waste disposal decisions. These include the results of safety analyses for disposal facility operation, the extent of existing contamination or waste disposal at a site, the costs and benefits involved in transporting waste among sites, and other environmental and socioeconomic concerns.

Table 7.4-10. Disposal Variables (by Site and Alternative) and Population Risk Vulnerability Group For LLW

Disposal Alternative Variables	ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
Population Risk Vulnerability Group	2	2	3	1	1	1	2	1	3	3	1	3	2	2	3	2
No Action Alternative																
Number of disposal units				6	5	14		29	12						39	
Disposal waste volume (m^3)				240,000	36,000	160,000		150,000	260,000						420,000	
Total radioactivity (Ci × 100,000)				76.6	27.6	77.3		330	1.27						17.9	
Decentralized Alternative																
Number of disposal units	1	1	NA	9	8	15	1	1	17	4	1	12	3	1	51	3
Disposal waste volume (m^3)	9,100	5,760		94,000	94,000	163,000	8,300	1,830	294,000	53,800	2,900	231,000	45,000	2,700	560,000	49,440
Total radioactivity (Ci × 100,000)	5.3E-02	0.12		1.55	27.6	77.3	6.37	3.6E-05	1.27	2.5E-04	9.6E-05	75	2.3E-03	5.1E-02	17.9	0.14
Regionalized 1 Alternative																
Number of disposal units			NA	9	7	14	1	NA	14	4	4	12	3		48	
Disposal waste volume (m^3)				94,000	94,000	166,000	8,300	1,830	294,000	53,800	2,900	295,000	45,000		560,000	
Total radioactivity (Ci × 100,000)				1.55	27.6	77.3	3.6	0	1.27	2.5E-04	9.6E-05	75	2.33E-02		17.9	
Regionalized 2 Alternative																
Number of disposal units			NA	2	4	5	1	NA	3	3	1	7	1		40	
Disposal waste volume (m^3)				20,700	51,000	50,900	6,200	0	130,000	41,500	2,920	123,000	12,000		455,000	
Total radioactivity (Ci × 100,000)				1.55	27.6	77.3	3.6	0	1.27	2.5E-04	9.6E-05	75	2.33E-02		17.9	
Regionalized 3 Alternative																
Number of disposal units				9	7	22		1	30						48	
Disposal waste volume (m^3)				94,000	94,000	255,000		6,840	415,000						560,000	
Total radioactivity (Ci × 100,000)				1.55	27.6	77.3		0.90	345						17.9	
Regionalized 4 Alternative																
Number of disposal units				2	4	7		1	13						40	
Disposal waste volume (m^3)				21,000	51,000	72,000		1,970	264,000						455,000	
Total radioactivity (Ci × 100,000)				2.87	27.6	77.3		5.4E-04	346						17.9	
Regionalized 5 Alternative																
Number of disposal units				2	5	7		1	13						40	
Disposal waste volume (m^3)				21,000	59,000	63,700		1,970	264,000						455,000	
Total radioactivity (Ci × 100,000)				2.87	27.6	77.2		5.4E-04	346						17.9	
Regionalized 6 Alternative																
Number of disposal units				37											94	
Disposal waste volume (m^3)				460,000											1,100,000	
Total radioactivity (Ci × 100,000)				113											93	

Table 7.4-10. Disposal Variables (by Site and Alternative) and Population Risk Vulnerability Group For LLW—Continued

Disposal Alternative Variables	ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
Regionalized 7 Alternative																
Number of disposal units								37							94	
Disposal waste volume (m^3)								270,000							1,100,000	
Total radioactivity (Ci × 100,000)								79							93	
Centralized 1 Alternative																
Number of disposal units				131												
Disposal waste volume (m^3)				1,500,000												
Total radioactivity (Ci × 100,000)				427												
Centralized 2 Alternative																
Number of disposal units								131								
Disposal waste volume (m^3)								1,500,000								
Total radioactivity (Ci × 100,000)								427								
Centralized 3 Alternative																
Number of disposal units				72												
Disposal waste volume (m^3)				810,000												
Total radioactivity (Ci × 100,000)				427												
Centralized 4 Alternative																
Number of disposal units								73								
Disposal waste volume (m^3)								810,000								
Total radioactivity (Ci × 100,000)								427								
Centralized 5 Alternative																
Number of disposal units				72												
Disposal waste volume (m^3)				810,000												
Total radioactivity (Ci × 100,000)				427												

Table 7.4–11. Disposal Variables by LLW Alternative and Population Risk Vulnerability Group

Alternative	Group 3	Group 2	Group 1
No Action Alternative			
Number of disposal units	51	0	54
Disposal waste volume (m^3)	680,000	0	586,000
Total radioactivity (Ci × 100,000)	17.9	0	511
Decentralized Alternative			
Number of disposal units	84	10	34
Disposal waste volume (m^3)	1,140,000	120,000	355,000
Total radioactivity (Ci × 100,000)	93	6.4	105
Regionalized 1 Alternative			
Number of disposal units	78	4	34
Disposal waste volume (m^3)	1,200,000	53,000	355,000
Total radioactivity (Ci × 100,000)	93	3.6	105
Regionalized 2 Alternative			
Number of disposal units	53	2	12
Disposal waste volume (m^3)	750,000	14,000	126,000
Total radioactivity (Ci × 100,000)	93	3.6	116
Regionalized 3 Alternative			
Number of disposal units	78	0	39
Disposal waste volume (m^3)	975,000	0	450,000
Total radioactivity (Ci × 100,000)	362	0	107
Regionalized 4 Alternative			
Number of disposal units	53	0	14
Disposal waste volume (m^3)	719,000	0	146,000
Total radioactivity (Ci × 100,000)	362	0	107
Regionalized 5 Alternative			
Number of disposal units	53	0	15
Disposal waste volume (m^3)	719,000	0	146,000
Total radioactivity (Ci × 100,000)	362	0	107
Regionalized 6 Alternative			
Number of disposal units	94	0	37
Disposal waste volume (m^3)	1,100,000	0	460,000
Total radioactivity (Ci × 100,000)	93	0	113

Table 7.4-11. Disposal Variables by LLW Alternative and Population Risk Vulnerability Group—Continued

Alternative	Group 3	Group 2	Group 1
Regionalized 7 Alternative			
Number of disposal units	94	0	37
Disposal waste volume (m^3)	1,100,000	0	270,000
Total radioactivity (Ci × 100,000)	93	0	79
Centralized 1 Alternative			
Number of disposal units	0	0	131
Disposal waste volume (cubic meters)	0	0	1,500,000
Total radioactivity (Ci × 100,000)	0	0	427
Centralized 2 Alternative			
Number of disposal units	0	0	131
Disposal Waste Volume (m^3)	0	0	1,500,000
Total radioactivity (Ci × 100,000)	0	0	427
Centralized 3 Alternative			
Number of disposal units	0	0	72
Disposal waste volume (m^3)	0	0	810,000
Total radioactivity (Ci × 100,000)	0	0	427
Centralized 4 Alternative			
Number of disposal units	0	0	73
Disposal waste volume (cubic meters)	0	0	810,000
Total radioactivity (Ci × 100,000)	0	0	427
Centralized 5 Alternative			
Number of disposal units	0	0	72
Disposal waste volume (cubic meters)	0	0	810,000
Total Radioactivity (Ci × 100,000)	0	0	427

7.4.1.9 Intruder Scenario Risks

Table 7.4–12 presents an overview, by alternative, of the total programwide risks to a hypothetical intruder 100 and 300 years after the disposal facility has closed. Because the focus is on an individual intruder, the risks are presented as the probability of that individual experiencing an adverse health impact rather than a total number of impacts for a selected population.

Table 7.4–12. LLW Disposal: Summary Risks to Hypothetical Intruders at LLW Sites

Alternative	Number of Sites T[a]	D	Dose (rem)	Cancer Fatality Probability	Cancer Incidence Probability	Genetic Effects Probability
100 Years After Disposal Facility Closure						
Decentralized		16	160	8E–02	3E–01	2E–02
Regionalized 3		6	110	5E–02	2E–01	1E–02
Centralized 1		1	2	8E–03	3E–02	2E–03
300 Years After Disposal Facility Closure						
Decentralized		16	2	8E–03	3E–03	2E–04
Regionalized 3		6	1	6E–04	2E–03	1E–04
Centralized 1		1	0.2	8E–05	3E–04	2E–05

Notes: T = treatment; D = disposal. Please refer to Section 5.4.1 of Volume 1 for guidance in interpreting hypothetical intruder risks.
[a] All sites perform "minimum treatment" under all alternatives, consisting of solidification of liquids and "fines" (powdered material), packaging, and shipment.

The intruder scenario risks were not estimated for all alternatives. Regionalized Alternative 3 and Centralized Alternative 1 were selected to be representative of the Regionalized and Centralized Alternatives, respectively. For both the 100-year and 300-year scenarios, each of the evaluated alternatives is estimated to result in relatively high maximum probabilities of cancer fatality, cancer incidence, and genetic effects from radionuclide and direct radiation exposure.

Table 7.4–13 presents the cancer fatality probabilities by site for each of the alternatives evaluated 100 years and 300 years after the disposal facility has closed. The data in Table 7.4–13 are graphically presented in Figure 7.4–3. Under the Decentralized Alternative, cancer fatality probability values span a range of about five orders of magnitude. Cancer fatality probabilities generally are lower for the 300-year scenario by one to two orders of magnitude under all alternatives, which suggests that risks decrease as radionuclides decay. Strontium-90 (half-life 29 years) was the main radionuclide risk driver at 100 years, under each of the alternatives evaluated, whereas the risk drivers at 300 years included thorium-232 (half-life 1E+10 years), uranium-238 (half-life 2E+09 years), nickel-63 (half-life 96 years), americium-241 (half-life 432 years),

Table 7.4–13. LLW Disposal: Hypothetical Intruder Cancer Fatality Probabilities 100 and 300 Years After Disposal Facility Closure

Site	Decentralized Alternative				Regionalized Alternative 3				Centralized Alternative 1			
	100 years		300 years		100 years		300 years		100 years		300 years	
	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)	Cancer Fatality Probability	Dose (rem)
ANL-E	3E–04	6.6E–01	4E–06	8.0E–03	--	--	--	--	--	--	--	--
Hanford	3E–03	6.8E+00	3E–05	6.0E–02	3E–03	6.8E+00	3E–05	6.0E–02	8E–04	1.7E+00	8E–05	1.7E–01
INEL	4E–04	7.0E–01	7E–05	1.3E–01	4E–04	7.0E–01	7E–05	1.3E–01	--	--	--	--
LANL	7E–02	1.4E+02	6E–04	1.2E+00	5E–02	9.1E+01	4E–04	7.6E–01	--	--	--	--
LLNL	3E–03	5.8E+00	5E–05	1.0E–01	--	--	--	--	--	--	--	--
NTS	--	--	--	--	3E–03	5.8E+00	5E–05	1.0E–01	--	--	--	--
ORR	7E–04	1.3E+00	5E–06	1.1E–02	4E–04	8.1E–01	3E–05	6.0E–02	--	--	--	--
PGDP	3E–06	7.0E–03	3E–06	7.0E–03	--	--	--	--	--	--	--	--
Pantex	3E–06	5.0E–03	3E–06	5.0E–03	--	--	--	--	--	--	--	--
PORTS	2E–04	4.8E–01	6E–05	1.2E–01	--	--	--	--	--	--	--	--
RFETS	1E–06	2.0E–03	1E–06	2.0E–03	--	--	--	--	--	--	--	--
SNL-NM	7E–04	1.5E+00	1E–05	3.0E–02	--	--	--	--	--	--	--	--
SRS	1E–03	2.3E+00	1E–05	3.0E–02	1E–03	2.3E+00	1E–05	3.0E–02	--	--	--	--

Notes: -- = action not applicable for the alternative. Please refer to Section 5.4.1 of Volume I for guidance in interpreting hypothetical intruder risks.

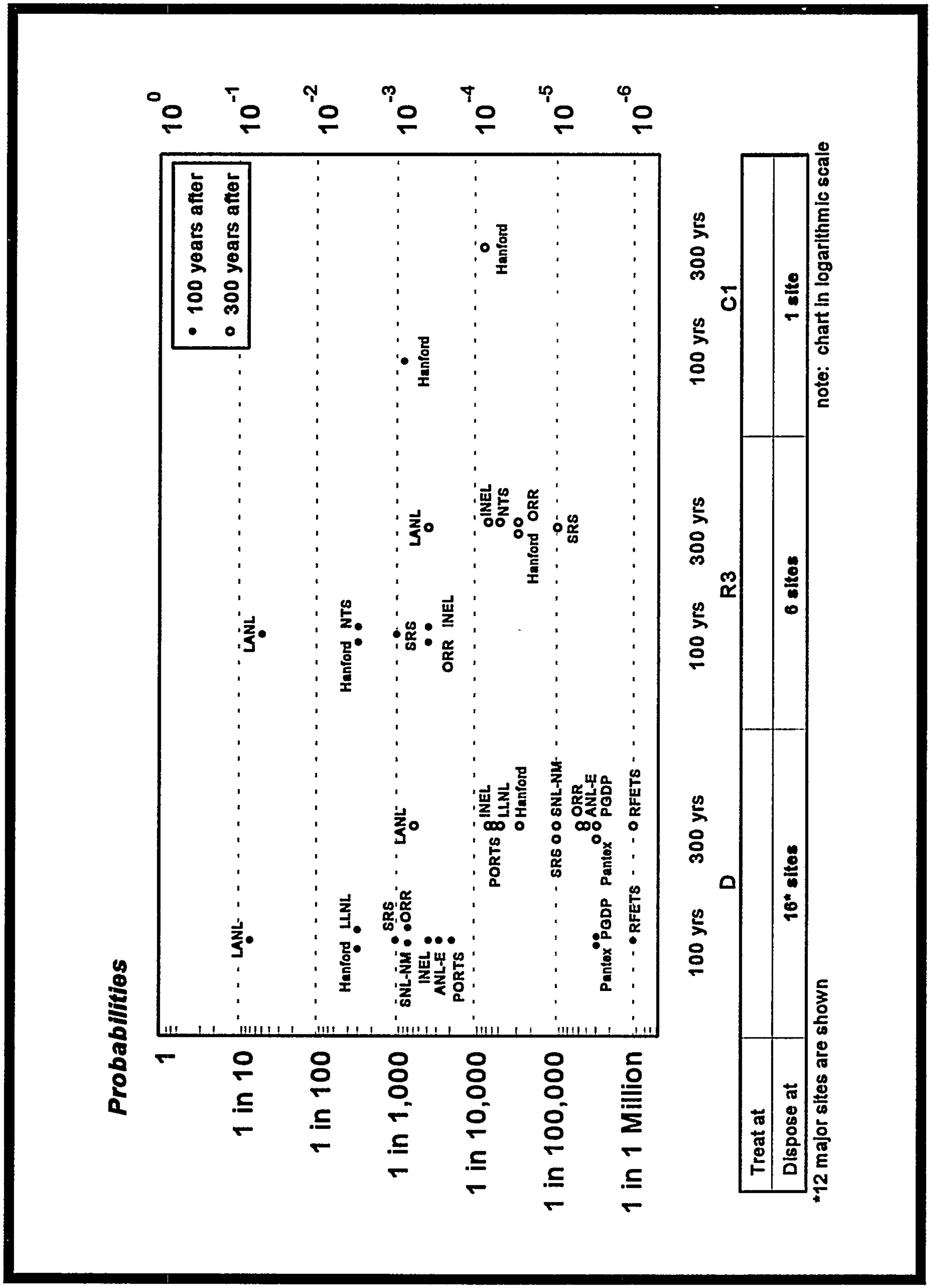

Figure 7.4-3. LLW Disposal: Probability of Cancer Fatality to an Intruder Into Disposal Facility 100 and 300 Years Post Closure

and neptunium-237 (half-life 2E+06 years). There is no general trend in intruder risk among the disposal alternatives evaluated.

The estimated doses presented in Tables 7.4–13 exceed the DOE Order 5820.2A (DOE, 1988) performance assessment objective limits for intruders of 100 millirem per year for continuous exposure and 500 millirem per year for acute exposure at LANL under the Decentralized and Regionalized 3 Alternatives. Figure 7.4–3 shows the intruder cancer fatality risks. Similar to the discussion in Section 7.4.1.7, site-specific considerations during design, construction, and operation would be expected to mitigate these exceedances. These mitigation measures are also described in Chapter 12.

7.4.2 Transportation-Related Impacts

Transporting LLW for treatment and disposal may affect the health of the truck or rail crew and the public along the transportation route. These impacts are the result of radiation exposure during normal operations, and accidents in which the waste containers are assumed to be opened, as well as exposure to vehicle exhaust and physical injury after vehicle accidents. For the No Action Alternative shipments, it was assumed that the shipments would be distributed uniformly over a 20-year period. For all other alternatives, shipments were assumed to occur uniformly over a 10-year period, assuming a 10-year period to build treatment, storage, and disposal facilities.

Tables 7.4–14 and 7.4–15 present the total number of estimated fatalities associated with truck and rail transportation of LLW, respectively. The total number of estimated fatalities resulting from radiation exposure when LLW is transported by truck ranges from less than 1 to 16 for the normal operations population and crew combined (Centralized Alternative 1). The number of estimated fatalities resulting from nonradiological causes (vehicle exhaust-induced cancers and physical injury resulting from accidents) ranges from 1 to 38 when LLW is transported by truck (Table 7.4–14). The number of estimated fatalities resulting from both radiological exposure and nonradiological causes ranges from less than 1 to approximately 5 when the LLW is transported by rail (Table 7.4–15).

Table 7.4-14. LLW Truck Transportation: Estimated Fatalities From Vehicular Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Number of Shipments	Shipment Miles (in Millions)	Estimated Number of Radiological Fatalities[a]			Estimated Number of Nonradiological Fatalities	
	T[b]	D			Normal Operations Public	Normal Operations Crew	Exposure From Traffic Accidents	Fuel Emission	Injury From Traffic Accidents
No Action	10[c]	6	87,360	166	3	2	*	1	11
Decentralized		16	24,420	9	*	*	*	*	1
Regionalized 1		12	25,800	9	*	*	*	*	1
Regionalized 2	11	12	25,880	9	*	*	*	*	1
Regionalized 3		6	84,200	38	1	1	*	*	3
Regionalized 4	7	6	87,390	37	1	1	*	*	3
Regionalized 5	4	6	92,200	64	1	1	*	*	4
Regionalized 6		2	174,390	124	2	2	*	1	9
Regionalized 7		2	188,930	125	2	2	*	1	9
Centralized 1		1	242,730	563	10	6	*	2	35
Centralized 2		1	257,270	505	9	6	*	3	35
Centralized 3	7	1	250,020	530	9	6	*	2	33
Centralized 4	7	1	264,060	478	8	6	*	3	34
Centralized 5	1	1	241,540	560	9	6	*	2	35

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced latent cancer.
[b] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.
[c] Ten sites use existing facilities for volume reduction.

Table 7.4-15. LLW Rail Transportation: Estimated Fatalities From Rail Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Number of Shipments	Shipment Miles (in Millions)	Estimated Number of Radiological Fatalities[a]			Estimated Number of Nonradiological Fatalities	
	T[b]	D			Normal Operations Public	Normal Operations Crew	Exposure From Traffic Accidents	Fuel Emission	Injury From Traffic Accidents
No Action	10[c]	6	33,420	70	*	*	*	1	*
Decentralized		16	9,210	4	*	*	*	*	*
Regionalized 1		12	9,740	4	*	*	*	*	*
Regionalized 2	11	12	9,900	4	*	*	*	*	*
Regionalized 3		6	31,850	17	*	*	*	*	*
Regionalized 4	7	6	33,460	17	*	*	*	*	*
Regionalized 5	4	6	35,430	25	*	*	*	*	*
Regionalized 6		2	66,040	51	*	*	*	1	*
Regionalized 7		2	71,480	54	*	*	*	1	*
Centralized 1		1	91,440	224	1	1	*	2	1
Centralized 2		1	96,880	219	1	1	*	2	1
Centralized 3	7	1	96,710	218	1	1	*	2	1
Centralized 4	7	1	102,100	212	1	1	*	2	*
Centralized 5	1	1	90,980	223	1	1	*	2	1

Notes: T = treatment; D = disposal; * = greater than 0 but less than 0.5.

[a] Fatalities are from radiation-induced latent cancer.

[b] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Ten sites use existing facilities for volume reduction.

The number of fatalities estimated for both truck and rail transportation is directly related to the number of shipments and shipment miles required under each alternative. Therefore, most fatalities from both truck and rail transport are estimated to occur in the alternatives that have the most shipments and vehicle miles, which are the Centralized Alternatives (when treatment and/or disposal of all LLW occur at one site). Approximately 250,000 truck shipments covering 500 to 600 million vehicle miles or approximately 100,000 rail shipments covering 200 million vehicle miles are required in the Centralized Alternatives. The least number of fatalities is estimated to occur in the Decentralized and Regionalized Alternatives, which require approximately 25,000 to 190,000 truck shipments covering 9 to 125 million vehicle miles, or approximately 10,000 to 70,000 rail shipments covering 4 to 50 million vehicle miles. Due to the uncertainties involved in the calculations (see Section E.8 of Volume I), these results suggest that there may not be significant differences between the radiological risks associated with truck and rail transport. However, members of the public traveling on the truck routes have a potential to receive higher exposures than those members of the public traveling near rail routes. The risks from injury directly related to traffic accidents suggest rail transport may be slightly less hazardous than truck transport.

7.4.3 FACILITY ACCIDENT IMPACTS

7.4.3.1 Storage Facility Accidents

Accidents and source terms for current storage of LLW were not analyzed. Unlike treatment, which will predominantly use new facilities that will have common characteristics, current (pretreatment) storage will use a variety of predominantly preexisting facilities that vary greatly in the amounts and types of waste inventories stored, the configurations in which they are stored, and the containment or confinement characteristics of the storage buildings or enclosures. However, recent DOE safety analysis reports (SARs) and NEPA information provide guidance on the potential risk impacts applicable to LLMW and TRUW storage facility accidents and can be used to evaluate the anticipated risks of LLW storage facility accidents.

Information in these current SARs and DOE site EISs can be used as indicators of the predicted consequences for a range of waste storage facility accidents of varying frequency. A brief summary of some of the key accidents and assumptions used by the sites in preparing these analyses, and the related health effects results are shown in Appendix F. Examples of results applicable to LLW storage facilities include accidents ranging from violent single drum breaches to large fires in centralized facilities. The recent SARs and EISs that are relevant portray results for TRUW and LLMW releases, and thus the consequences, per se, are not directly comparable to those for LLW. However, the accident scenarios, estimates of airborne material due to the accidents, and atmospheric dispersion and health effects calculations are analogous. As a result, LLW storage facility accident results are analogous to LLMW storage facility results because of their similar radionuclide profiles. See Section 6.4.3 for a discussion of these results which suggest that the public risk from storage accidents is very low.

It should be noted that explicitly analyzing risks from storage would not help to discriminate among alternatives because of the assumption used in the WM PEIS for estimating the treatment throughputs that dictate the inventories to be stored prior to treatment. This assumption is that all sites will accumulate or at least not reduce these inventories for roughly 10 years, at which time complex-wide treatment will begin. Thus, all sites will achieve their maximum inventories (leading to maximum potential releases during a storage facility accident) independently of alternative.

7.4.3.2 Treatment Facility Accidents

Although there are many processes used for treating LLW, to date, thermal treatment technologies have been the most effective in destroying and reducing in volume the combustible materials contained in LLW. Because significant data on incineration are available and because the results achieved through incineration are representative and bounding of other thermal treatment processes, this risk analysis focused on incineration. Like other LLW treatment processes, incinerator operations/accidents can result in airborne releases of radionuclides. Potential treatment facility accidents identified for all LLW alternatives include: (1) incineration facility fires or explosions initiated from internal causes; (2) an earthquake or tornado that causes damage and possible fires in the facility; and (3) the crash of a large or small aircraft into the facility resulting in fire and possible explosion. All of these accidents can involve release of the radioactive contents of the kiln, the stored ash byproduct of the incineration process, or the trapped contents of the filtration systems in the facility. The accident with the highest potential consequences at each site was evaluated.

The radiological risks and health effects calculations were based upon very conservative assumptions. Table 7.4–16 summarizes the estimated cancer fatalities resulting from radiation exposures associated with potential treatment facility accidents. This table contains cancer fatality estimates for the maximum reasonably foreseeable accidents with the highest potential consequences at each site and the estimated

Table 7.4-16. LLW Facility Accidents: Radiation-Induced Cancer Fatalities From Maximum Reasonably Foreseeable Potential Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Dose (rem)	Offsite MEI Cancer Fatality Probability	Offsite Population Dose (person-rem)	Offsite Population Number of Cancer Fatalities	Worker Dose (person-rem)	WM Workers Number of Cancer Fatalities
No Action Alternative								
INEL	Thermal Treatment, Aircraft Crash[a]	<1E-06	1E-05	7E-09	1E-01	*	5E-02	*
SRS	Thermal Treatment, Aircraft Crash[a]	<1E-06	2E-03	1E-06	1E+02	*	3E+01	*
Regionalized Alternative 2								
FEMP	Thermal Treatment, Natural Phenomena	<1E-06 to <1E-04	4E-05	2E-08	1E-01	*	1E-03	*
Hanford	Thermal Treatment, Aircraft Crash[a]	<1E-06	1E-04	6E-08	4E+00	*	3E-02	*
INEL	Thermal Treatment, Aircraft Crash[a]	1E-06 to 1E-04	1E-05	7E-09	1E-01	*	5E-02	*
LANL	Thermal Treatment, Natural Phenomena	1E-06 to 1E-04	8E-01	4E-04	2E+03	1	8E+02	*
LLNL	Thermal Treatment, Natural Phenomena	1E-06 to 1E-04	8E-01	4E-04	6E+03	3	1E+01	*
ORR	Thermal Treatment, Natural Phenomena	1E-06 to 1E-04	2E-03	1E-06	3E+01	*	2E+00	*
PGDP	Thermal Treatment, Natural Phenomena	1E-06 to 1E-04	1E-04	7E-08	6E-01	*	1E-01	*
PORTS	Thermal Treatment, Natural Phenomena	1E-06 to 1E-04	4E-05	2E-08	6E-02	*	1E-02	*
RFETS	Thermal Treatment, Natural Phenomena	1E-06 to 1E-04	2E-03	1E-06	6E+01	*	5E+00	*
SRS	Thermal Treatment, Aircraft Crash	<1E-06	2E-03	1E-06	1E+02	*	3E+01	*
Centralized Alternative 5								
Hanford	Thermal Treatment, Aircraft Crash	<1E-06	2E-01	1E-04	1E+04	5	2E+03	1

Notes: "Natural Phenomena" refer to accidents initiated either by earthquake or by high wind or tornado, depending on the site and the associated recurrence frequencies. Incineration was the thermal treatment analyzed. * = greater than 0 but less than 0.5. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] The aircraft crash scenario is included because of its high estimated consequences even though it may not be considered "reasonably foreseeable" in terms of accident frequency (i.e., annual frequency of occurrence greater than 1E-06).

frequency of those accidents occurring annually. The doses indicated are a function of the severity of the accident and the size and distribution of the population affected. The indicated probabilities of excess cancer are based on the assumption that the accident occurs.

Consistent with standard practice in radiological safety analysis, the fatalities are derived only from the cancers associated with radiation. In general, local worker fatalities in severe accidents from trauma would primarily result from the initiation of the accident, e.g., the initial impact and fire of an airplane crash. These trauma fatalities would tend to be independent of the inventory or process characteristics of a particular site for a given consolidation alternative and, therefore, would not tend to be a significant discriminator among the alternatives. Trauma fatalities to the offsite populations from severe accidents would be almost totally independent of the site consolidation and process characteristics that are driven by alternative selection and would not discriminate among alternatives.

Assuming that the accident occurs, each of the alternatives poses a cancer fatality probability equal to or greater than one in one million for the offsite MEI. Under the No Action Alternative, the cancer fatality probability is estimated to be equal to one in one million for the indicated accident affecting the offsite MEI at SRS. Under Regionalized Alternative 2, an offsite MEI cancer fatality probability of equal to or greater than one in one million is estimated for accidents at five sites (LANL, LLNL, ORR, RFETS and SRS). Centralized Alternative 5 is expected to have an offsite MEI cancer fatality probability of greater than one in one million for accidents at the Hanford Site. However, when the frequencies of the accidents are considered, none of the alternatives pose an offsite MEI cancer risk of greater than one in one million.

Centralized Alternative 5 is estimated to produce the highest number of cancer fatalities resulting from accidents affecting the offsite population (5 individuals at the Hanford Site). Under Regionalized Alternative 2, three cancer fatalities in the offsite population are estimated to result from accidents at LLNL, and one cancer fatality is estimated in the offsite population at LANL. Under the No Action Alternative, no cancer fatalities within the offsite population are estimated. The overall risks from accidents for all the alternatives, derived by multiplying the health risk value by the frequencies of the accidents, are very small.

Only Centralized Alternative 5 is expected to produce a cancer fatality within the WM worker population as a result of radiation exposures from severe accidents. The overall risk from severe accidents, taking into account the very low frequency of these accidents, is much less. It is also important to note that use of the latest safety analysis documentation (described in the preceding section on storage facility accidents) would reduce all predicted impacts. In addition, the health risks presented in Table 7.4–16 assume no mitigation of the accident and take no credit for emergency response actions. The reduction in impacts due to these mitigation actions would be significant.

7.4.3.3 Disposal Facility Accidents

As discussed in Appendix F, disposal accidents were not evaluated because of the lack of details of ultimate disposal. However, except for dedicated centralized disposal facilities (e.g., Yucca Mountain and WIPP for HLW and TRUW, respectively), disposal sites would generally lack a concentrated volume of material at risk being stored in a configuration susceptible to phenomena such as fires and explosions capable of causing significant releases. These repositories have accident analyses performed as part of their site-specific EISs. Although seismic events could breach in-ground containers, leading to airborne releases, such events would be bounded by accidents breaching the concentrated volumes of waste being held in a treatment or storage facility. The available safety literature does not indicate any credible accident sequence in which the risk from airborne releases in a low-level waste disposal facility would be sufficiently significant to rule out a site from consideration and thereby serve as a discriminator among disposal alternatives.

7.5 Air Quality Impacts

The management of LLW would not appreciably affect the air quality at most sites. However, decentralizing treatment and disposal at BNL, or centralizing at NTS could cause adverse air quality impacts requiring additional emission control measures for criteria pollutants. Emissions of radionuclides were estimated to be below the applicable standards at all sites.

As illustrated in Table 7.5–1, DOE evaluated air quality impacts at each proposed LLW treatment and disposal site based on estimated increases in emissions of the six criteria pollutants and radionuclides. Pollutant emission estimates were made for the construction and O&M activities of LLW facilities.

The Clean Air Act (42 USC 7401 *et seq.)* regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new emissions

Table 7.5–1. Air Quality Impacts Evaluated for LLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Table 7.5–2
	Operations	Estimated for thermal treatment units for fuel use by all other LLW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Table 7.5–3
Radionuclide emissions	Operations	For all LLW treatment and disposal facilities	Percent of standard	Text discussion only

from both "stationary" (e.g., treatment and storage facilities) and "mobile" (e.g., vehicles) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for each criteria air pollutant for nonattainment areas. An entity which seeks to engage in an activity that will result in emissions that equal or exceed those limits in a nonattainment area must first obtain a permit.

In "attainment areas" (where air pollution standards are met), only new emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit is required for a new stationary source that equal or exceeds the allowable increase. However, a permit is not required for criteria pollutant emissions from mobile sources.

7.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site. Both are considered to be "mobile sources."

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities

> ***Major Types of Air Pollutants***
>
> ***Criteria Air Pollutants****—carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10}).*
>
> ***Hazardous Air Pollutants****—189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act.*

under all the LLW alternatives would result in mobile source emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. Table 7.5–2 lists those sites. DOE chose the 10% threshold to highlight those sites where criteria air pollutant emissions could result in adverse air quality impacts.

As indicated in Table 7.5-2, six of the 16 major proposed LLW sites are located in nonattainment areas. As a result of LLW construction activities, these sites are predicted to have emissions that equal or exceed 10% of the allowable limit for a particular criteria air pollutant. NTS is predicted to have emissions of 189% of allocated limits under the Centralized Alternative 2 and 128% under Centralized Alternative 4. This analysis may overestimate potential impacts because it assumes that NTS is in a nonattainment region since it is adjacent to the Clark County nonattainment region for CO and PM_{10}. The NTS EIS (DOE, 1996b) does not show any exceedances for criteria air pollutants. For carbon monoxide, BNL is estimated to be at the limit in the Decentralized Alternative. The WM PEIS analysis suggests that NTS and BNL may need to obtain Clean Air Act permits under these alternatives.

7.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants would also be emitted during operations and maintenance of LLW facilities (stationary sources) and by vehicles driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

Twelve of the 16 major proposed LLW sites are predicted to equal or exceed 10% of applicable air pollutant emission standards (Table 7.5–3). Of these, six sites are located in nonattainment areas; six sites are in attainment areas. As many as seven sites would have pollutant standards that equal or exceed 10% of the levels under an alternative. Only NTS is estimated to exceed the standard; carbon monoxide would be 118 to 183% above the standard in the Centralized 2 and Centralized 4 Alternatives, primarily from worker vehicle emissions. This analysis may overestimate potential impacts because it assumes that NTS is in a nonattainment region since it is adjacent to the Clark County nonattainment region for CO and PM_{10}. The NTS EIS (DOE, 1996b) does not show any exceedances for criteria air pollutants. Based on the

Table 7.5-2. Percent of Sites' Allowable Air Emissions Discharged During Construction—LLW Sites Equaling or Exceeding 10% of Standard in Nonattainment Regions[a]

Alternative	Number of Sites		Criteria Pollutants—Construction[b]										
			ANL-E	BNL		NTS		PGDP		RFETS			SNL-NM
	T[c]	D	NO_2	NO_2	VOC	CO	PM_{10}	NO_2	VOC	CO	NO_2	VOC	CO
No Action	10[d]	6	36 (31/5)	26 (20/6)				13 (11/2)		12 (4/8)	12 (10/2)		
Decentralized		16	58 (52/6)	100 (88/12)	15 (8/7)			88 (85/3)	20 (16/4)	28 (16/12)	45 (43/2)	11 (8/3)	10 (1/9)
Regionalized 1		12	12 (6/6)	26 (20/6)				88 (85/3)	20 (16/4)	28 (16/12)	45 (43/2)	11 (8/3)	10 (1/9)
Regionalized 2	11	12	12 (6/6)	26 (20/6)				81 (74/7)	22 (14/8)	38 (28/10)	76 (74/2)	16 (14/2)	10 (1/9)
Regionalized 3		6	12 (6/6)	26 (20/6)		12 (5/7)				15 (1/14)			10 (1/9)
Regionalized 4	7	6	12 (6/6)	26 (20/6)						26 (21/5)	55 (54/1)	11 (10/1)	10 (1/9)
Regionalized 5	4	6	12 (6/6)	26 (20/6)						15 (1/14)			10 (1/9)
Regionalized 6		2	12 (6/6)	26 (20/6)						15 (1/14)			10 (1/9)
Regionalized 7		2	12 (6/6)	26 (20/6)		64 (20/44)				15 (1/14)			10 (1/9)
Centralized 1		1	12 (6/6)	26 (20/6)						15 (1/14)			10 (1/9)
Centralized 2		1	12 (6/6)	26 (20/6)		189 (79/110)	16 (16/0)			15 (1/14)			10 (1/9)
Centralized 3	7	1	12 (6/6)	26 (20/6)						26 (21/5)	55 (54/1)	11 (10/1)	10 (1/9)
Centralized 4	7	1	12 (6/6)	26 (20/6)		128 (49/79)	10 (10/0)			26 (21/5)	55 (54/1)	11 (10/1)	10 (1/9)
Centralized 5	1	1	12 (6/6)	26 (20/6)						15 (1/14)			10 (1/9)

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives use the same sites; each of the 12-site disposal alternatives use the same 12 sites.

[a] Values less than 10% are shown as blanks. Refer to the *Waste Management Environmental and Socioeconomic Impacts Methods and Results Technical Report* (DOE, 1996a) for complete results. CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter equal to or less than 10 micrometers in diameter, NO_2 = nitrogen dioxide; VOC = volatile organic compounds.

[b] Sites that exceed 10% of the standard specified by the General Conformity rule; total % (% equipment /% worker vehicles). Sites that do not exceed 10% are left blank.

[c] All sites perform "minimum treatment" under all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[d] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

analysis performed for the WM PEIS, mitigation measures may be needed at NTS to reduce emissions of carbon monoxide to acceptable levels. These mitigation measures could include ride sharing, transit programs, parking management, compressed work weeks, flextime, and telecommuting. Mitigation could also include reducing emissions from existing activities to compensate for increased emissions from new WM activities. More recent estimates show increased releases of criteria air pollutants at ANL-E (see Appendix I).

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because of national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 km (62 miles) of a PSD Class I area. Nine sites proposed for LLW activities under the alternatives are located within 100 km of a PSD area: BNL, FEMP, INEL, LANL, LLNL, NTS, ORR, RFETS, and SNL-NM. None of these would have sufficient quantities of emissions to affect a PSD Class I area.

Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). No site was estimated to equal or exceed 10% of the standards.

7.5.3 Hazardous Air Pollutant Emissions

Thermal treatment of LLW will result in emission of small quantities of radionuclides. Since by definition LLW does not contain significant quantities of hazardous chemicals, emissions of other hazardous air pollutants were assumed to be negligible. Radionuclides from air emissions were evaluated by comparing the annual radiation dose to a maximally exposed individual (MEI) to the National Emissions Standard for Hazardous Air Pollutants—10 millirems per year (mrem/yr) (40 CFR 61).

Doses from airborne radionuclides were estimated not to equal or exceed 10% of the dose standard at any site except for LLNL (13%) under Regionalized Alternative 2. This exceedance is due to thermal treatment of LLW.

Table 7.5-3. Percent of Sites' Allowable Air Emissions Discharged During Operations—LLW Sites Equaling or Exceeding 10% of Standard[a]

Alternative	Number of Sites		Criteria Pollutants—Operations and Maintenance: PSD or General Conformity																			
			ANL-E	BNL	Hanford		INEL		LANL	NTS	ORR		PORTS		PGDP		RFETS			SNL-NM	SRS
	T^b	D	NO_2^c	NO_2^c	NO_2^d	PM_{10}^d	NO_2^d	PM_{10}^d	PM_{10}^d	CO^e	NO_2^d	PM_{10}^d	NO_2^d	PM_{10}^d	NO_2^c	VOC^c	CO^e	NO_2^c	VOC^c	CO^e	NO_2^d
No Action	10^f	6								67 (0/67)											11
Decentralized		16	17 (2/15)	14 (4/10)							21	10	11		10 (3/7)		39 (0/39)			13 (0/13)	
Regionalized 1		12									21	10	16		10 (3/7)		39 (0/39)				
Regionalized 2	11	12							12				16	10	11 (3/8)	10 (0/10)	55 (0/55)	12 (1/11)	13 (0/13)		
Regionalized 3		6								11 (0/11)	47	21					11 (0/11)				
Regionalized 4	7	6							13		22	12					33 (0/33)				
Regionalized 5	4	6					15	22			27	18					11 (0/11)				
Regionalized 6		2															11 (0/11)				
Regionalized 7		2								67 (0/67)							11 (0/11)				
Centralized 1		1			19												11 (0/11)				
Centralized 2		1								183 (0/183)							11 (0/11)				
Centralized 3	7	1			19				12								33 (0/33)				
Centralized 4	7	1							12	118 (0/118)							33 (0/33)				
Centralized 5	1	1			27	36											11 (0/11)				

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives use the same sites; each of the 12-site disposal alternatives use the same 12 sites. CO = carbon monoxide; SO_2 = sulfur dioxide; PM_{10} = Particulate matter less than or equal to 10 micrometers in diameter; VOC = volatile organic compound.

[a] Blank cells are less than or equal to 10%.

[b] All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Nonattainment area for the pollutant ozone; NO_2 and VOC are ozone precursor emissions; General Conformity regulations applied; total % (% stationary-source / % mobile-source).

[d] Attainment area for this pollutant; PSD regulations applied; total % represents stationary-source emissions only.

[e] Nonattainment area for this pollutant; General Conformity regulations applied; total % (% stationary-source / % mobile-source).

[f] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

7.6 Water Resources Impacts

Major impacts to water availability from increased water use at the sites are unlikely, although there is the potential for adverse impacts at LLNL Site-300 and the WVDP. Modeling indicates that groundwater concentration reduction measures may be needed for radionuclides when disposal occurs at the Hanford Site, Paducah, SNL-NM, and SRS. Concentration reduction measures would not be needed when disposal occurs at NTS, even under the Centralized 2 and 4 (one disposal site) Alternatives.

As illustrated in Table 7.6–1, DOE analyzed the impacts on water resources of treatment and disposal activities. DOE evaluated the effects on water availability from building and operating treatment and disposal facilities. DOE also examined the effects of migration of radionuclides from disposal facilities on groundwater quality.

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from effluent discharges
- Impacts on small onsite streams from effluent discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface water and groundwater quality from routine transportation and transportation accidents

7.6.1 Water Availability

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of LLW facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite stream at a given site.

Table 7.6–1. Water Resource Impacts Evaluated for LLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts are Assessed	Impacts Measure	Location of Impacts Assessment
Water Availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Table 7.6–2
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used: • by personnel • by treatment and disposal processes	Percent increase in current water use	Table 7.6–2
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only
Groundwater Quality	Post-Closure	Disposal of LLW	Percent of drinking water quality standard	Table 7.6–3

Table 7.6–2 identifies sites where projected water usage under any alternative would increase by more than 1%. This 1% threshold is based on the assumption that lesser changes are not likely to have significant impacts.

Eleven of the 16 major sites are predicted to exceed the 1% threshold. Most exceedances shown are due largely to water used during the 2- to 3-year period for construction of treatment and disposal facilities. Nine of these sites, ANL-E, FEMP, the Hanford site, INEL, NTS, ORR, Portsmouth, RFETS, and SRS, are not likely to experience adverse impacts because of sufficient capacities and the relatively small amount of additional water needed (DOE, 1996a). Two sites that could experience adverse impacts, LLNL and WVDP, are discussed further.

Water use at LLNL would exceed 1% of current use for all alternatives, and approach 23% under Regionalized Alternative 2. This is based on the conservative assumption that water at Site 300, the assumed location for proposed waste management facilities at LLNL, would be supplied by groundwater. However, most of the water would probably be supplied by the new municipal hook-up to Site 300, or the Livermore Valley municipal system that currently serves LLNL. If the water were supplied by the new 500,000 gallons

Table 7.6–2. Maximum Percent of Current Water Use for Construction or Operations—LLW Sites Predicted to Exceed 1%[a]

Alternative	Number of Sites		ANL-E	FEMP	Hanford	INEL	LLNL	NTS	ORR	PORTS	RFETS	SRS	WVDP
	T[b]	D											
No Action	10[c]	6					1.4					1.4	9.2
Decentralized		16	1.9				8.1		1.4		4.6	6.6	84
Regionalized 1		12					8.1		1.4	1.3	4.6	6.6	9.2
Regionalized 2	11	12		1.3			23			1.1	6.6	6.2	9.2
Regionalized 3		6					4.8		2.9		1.5	6.6	9.2
Regionalized 4	7	6					4.8		1.5		4.2	6.2	9.2
Regionalized 5	4	6				1.1	4.8		1.5		1.5	6.2	9.2
Regionalized 6		2					4.8				1.5	11	9.2
Regionalized 7		2					4.8				1.5	11	9.2
Centralized 1		1					4.8				1.5	1.5	9.2
Centralized 2		1					4.8	4.0			1.5	1.5	9.2
Centralized 3	7	1					4.8				4.2	1.7	9.2
Centralized 4	7	1					4.8	2.5			4.2	1.7	9.2
Centralized 5	1	1			2.1		4.8				1.5	1.5	9.2

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. D = Dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites.

[a] Blank cells are less than or equal to 1%. Water sources assumed as follows: Groundwater for ANL-E, FEMP, INEL, LLNL, NTS, Ports, and SRS; Surface water for the Hanford site, ORR and WVDP; and Municipal water for RFETS.

[b] All sites perform "minimum treatment" under all alternatives consisting of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

per day municipal hook-up at Site-300, the maximum water use would be 4.1% of the capacity of the system. If the water were supplied by the municipal system in Livermore Valley, it would be 2.8% of the current water use rate of 717,000 gallons per day. If water for LLNL is supplied by an offsite municipal system, onsite water resources would not be affected. Therefore, adverse impacts to onsite water resources are unlikely. Impacts on the source of the municipal supply are not within the scope of this PEIS.

Water use at WVDP would be 84% of current use for the Decentralized Alternative. Water at WVDP would be supplied by surface water from two onsite reservoirs that impound water on tributaries of Buttermilk

Creek. Water use would be 53% of the 110,000-gallons-per-day capacity of the water supply system and less than 1% of the average flow in Buttermilk Creek of 41 million gallons per day. Major impacts to surface water levels and availability would be unlikely.

As shown in the Volume II tables, for DOE sites that withdraw water directly from a surface water source (the Hanford site, ORR, Paducah, and WVDP), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (ANL-E, FEMP, ORR, Paducah, Portsmouth, RFETS, SRS, and WVDP), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

7.6.2 Water Quality

DOE evaluated the impacts to groundwater quality caused by the migration of radionuclides that leach from disposal facilities over time. DOE calculated concentrations of radionuclides at a hypothetical well located 300 meters from the center of the disposal facility, and compared these to DOE or EPA drinking water standards (which have been adopted in DOE's internal orders). For radionuclides, the allowable drinking water concentrations equate to a 4 mrem per year effective dose equivalent.

The drinking water standards are used as comparison criteria for groundwater quality. Although they are not enforceable standards, they are often used as goals for contaminated site cleanup actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Because EPA established the drinking water standards to protect human health, groundwater concentrations of radionuclides at or below these levels present a low risk.

The discussions of impacts concentrate on contaminants that are near or exceed drinking water standards. Concentrations in the groundwater that equal or exceed 25% of the drinking water standard are presented.

Table 7.6–3 identifies sites where LLW would be disposed and where, under any alternative, the calculated value for any pollutant would exceed 25% of the drinking water standards.

Table 7.6-3. Percent of Drinking Water Standards in Groundwater From Disposal of LLW — Sites Exceeding 25% of Standard [a]

Alternative	Number of Sites		BNL	Hanford			PGDP	SNL-NM					SRS	
	T[b]	D	Tc-99	Tc-99	U-234	U-238	Np-237	Pu-239	Pu-240	Tc-99	U-234	U-238	Np-237	U-238
No Action	10[c]	6				100*	--	--	--	--	--	--		100*
Decentralized		16	30			100*	100	100*	100*	100*	100*	100*		100*
Regionalized 1		12				100*	100	--	--	--	--	--		100*
Regionalized 2	11	12				100*	100*	--	--	--	--	--		100*
Regionalized 3		6				100*	--	--	--	--	--	--		100*
Regionalized 4	7	6		30	30	100*	--	--	--	--	--	--		100*
Regionalized 5	4	6		30	30	100*	--	--	--	--	--	--		100*
Regionalized 6		2			40	100*	--	--	--	--	--	--	60	100*
Regionalized 7		2		--	--	--	--	--	--	--	--	--	60	100*
Centralized 1		1				100*	--	--	--	--	--	--	--	--
Centralized 2		1		--	--	--	--	--	--	--	--	--	--	--
Centralized 3	7	1				100*	--	--	--	--	--	--	--	--
Centralized 4	7	1		--	--	--	--	--	--	--	--	--	--	--
Centralized 5	1	1				100*	--	--	--	--	--	--	--	--

Notes: T = treatment. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D=disposal. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = no disposal at this site under this alternative. * = PEIS modeling indicates that a reduction in the estimated concentration in the groundwater would be necessary to meet drinking water standards. See Volume II tables for the value of the exceedance.

[a] Only radionuclides equal to or above 25% of drinking water standards are listed. Blanks indicate concentrations less than 25% of standards. See Appendix C for a list of the drinking water standards.

[b] All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above, include volume reduction facilities.

Disposal of LLW at BNL, the Hanford Site, Paducah, SNL-NM, and SRS is predicted to cause 25% of drinking water standards for radionuclides to be exceeded in the groundwater. BNL is located above an EPA-designated sole-source aquifer. Twenty-five percent of standards would not be exceeded when LLW is disposed at ANL-E, INEL, LANL, LLNL, NTS, ORR, the Pantex Plant, Portsmouth, RFETS, or WVDP. Only under the Centralized 2 and 4 Alternatives (disposal of all LLW at NTS) are 25% of drinking water standards not exceeded at any site. More recent estimates show increased releases of uranium-238 at Hanford and SRS (see Appendix I).

Radionuclides that would exceed 25% of the drinking water standards are neptunium-237, plutonium-239, plutonium-240, technetium-99, uranium-234, and uranium-238. These radionuclides all have long half-lives, with the minimum half-life being 6,537 years for plutonium-240. Shorter half-life radionuclides (e.g., cesium-137, strontium-90) tend to decay to acceptable levels before reaching the 300-meter well.

For radionuclides with long half-lives, disposal inventory, infiltration rate, depth to groundwater, and the character of the media through which the water flows are some of the primary factors that determine the concentration in the groundwater. The infiltration rate is related to rainfall; sites in arid regions generally perform better than sites in humid regions because of their smaller infiltration rate. Sites with a large depth to groundwater are generally better because of longer travel times. Sites located over areas with large percentages of materials that retard the movement of radionuclides (e.g., clays, organic materials) generally perform better than sites located over areas devoid of these materials.

Uranium-238 is the most problematic radionuclide, exceeding 100% of the standard at three sites (the Hanford site, SNL-NM, and SRS). In all of these cases, concentrations in the groundwater would have to be reduced to meet drinking water standards. Neptunium-237 (Paducah), plutonium-239 (SNL-NM), plutonium-240 (SNL-NM), technetium-99 (SNL-NM), and uranium-234 (SNL-NM) would also have to be reduced to meet drinking water standards. Measures that could be used to reduce the estimated concentration of radionuclides in the groundwater include:

- Modifying the engineering design of the disposal facility (e.g., addition of a clay liner to increase adsorption or a concrete cap to reduce infiltration)
- Modifying the form of the waste to be disposed to reduce the release rate (e.g., changing to a vitrified waste form)

- Changing the specific location of the disposal facility so it is sited over an area with more favorable hydrologic conditions
- Imposing waste acceptance criteria (i.e., restricting the amount of the radionuclide allowed in the disposal facility)

The performance of disposal facilities at a specific site would also be evaluated in greater detail in DOE's Performance Assessment process under DOE Order 5820.2A (DOE, 1988). This process would help to ensure that all regulatory requirements are met and significant contamination of groundwater would not occur.

7.7 Ecological Resources Impacts

Loss of limited acreages of habitat at some LLW sites during construction site clearing would not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. Because construction site acreages are small compared to the total acreage at each site suitable for waste operations, DOE would be able to locate new LLW facilities to avoid impacts to nearby wetlands and other sensitive habitats. A screening level risk assessment of LLW facility airborne emissions indicated that terrestrial wildlife species are not likely to be affected. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to ecological resources, including threatened and endangered species, based on site-specific conditions. Transportation accidents leading to spills of LLW into aquatic environments could have serious short and long term consequences, but would be extremely rare. The Centralized alternatives have the highest probability of accidents because they require the greatest number of shipments; the Decentralized Alternative has the lowest probability.

As illustrated by Table 7.7–1, DOE analyzed the effects of construction site clearing to build LLW treatment and disposal facilities, and the operation of treatment facilities on ecological resources at representative sites. Accidental releases during intersite transportation of LLW, that could affect aquatic resources offsite, were also evaluated.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats

Table 7.7–1. Ecological Resources Impacts Evaluated for the LLW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive Habitat Effects	Terrestrial plants and animals	Comparison of habitat loss at LLW construction sites to general habitat range.	Text discussion only
Terrestrial Species Exposures	Terrestrial animal species	Comparison of estimated radiation dose of representative species with toxicity standard.	Text discussion only
Sensitive Habitat Effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats by comparing construction acreage to available acreage of nonsensitive habitats.	Text discussion only
Sensitive Species Concerns	Federally- and State-listed endangered and threatened species	Numbers of Federally- and State-listed species displayed by site/alternative.	Table 7.7–2
Effects of Transportation Accidents	Aquatic species in streams crossing transportation corridors	Results of scenario-based modeling analysis of accidental spill effects on fish in various size streams.	Text discussion only

based on site-specific conditions. Should sitewide or project-level NEPA reviews indicate that a site is not suitable for a waste management facility because of adverse impacts to sensitive species or habitats that cannot be avoided or mitigated, then DOE will reconsider its decision to locate a waste management facility at that site.

7.7.1 General Impacts of Site Clearing

None of the alternatives would require extensive site clearing for construction of LLW facilities. No more than 86 acres would be disturbed at any site under any LLW alternative. These acreage requirements are small compared to the available habitat for nonsensitive species represented at the sites. Although site clearing would destroy individual plants and would kill or displace individual animals (particularly small mammals and song birds with limited home ranges), no significant effects to populations of these species are expected from the implementation of the LLW alternatives because nonsensitive species habitats are well established regionally.

7.7.2 Site Clearing Effects on Sensitive Habitats

For those sites that contain sensitive habitats, the degree to which these habitats may be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby LLW construction activities depends on DOE's ability to avoid siting near these habitats. A measure of this ability is the percentage of available land required for facility construction under any LLW alternative. Available acreage was estimated from site development plans either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage required for LLW facilities ranged from 0.0001% at NTS (under Regionalized Alternative 6 and Centralized Alternatives 1, 3, and 5) to 10.9% at WVDP (under Decentralized Alternative). Considering the available land required for the LLW facilities, DOE should have a great degree of flexibility in their siting and can employ a range of mitigative measures, so that site clearing to implement any of the LLW alternatives should not affect adjacent sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff of water and soil to surface waters from construction sites. However, proper construction practices would minimize these effects. Direct discharges to surface waters from the routine operation of treatment facilities would comply with applicable regulations and would be limited by the use of accepted engineering techniques. Therefore, the impacts to aquatic organisms are expected to be minimal.

7.7.3 Effects of LLW Treatment Facility Emissions

DOE used atmospheric emissions and deposition modeling to estimate the toxicity to terrestrial animals from airborne emissions of radionuclides from treatment facilities. This analysis used the same atmospheric emissions estimates as the human health risk assessment and provided estimates of radionuclides deposited on surface soils.

For this analysis, DOE examined those sites with the highest anticipated emissions. Potential toxicity to terrestrial wildlife was analyzed for selected sites under the No Action, Decentralized Alternative, Regionalized Alternatives 2 and 5, and Centralized Alternative 5. The radionuclides Cs-137, H-3, Ni-63, Co-60, Sr-90, U-238, Pu-238, Pu-239, Pu-241, Y-90, Am-241, Pm-147, Th-234, and Ba-137 were selected for the analysis. These radionuclides comprised 80% of the total activity expected to be emitted. The remaining activity was contributed by smaller emissions of a large number of radionuclides. The conservative assumptions used to characterize the scenario (e.g., accumulation of contaminants for 10-year period with no loss due to decay or transport) might compensate for limiting the analyses to 80% of the released activity. The concentrations of these radionuclides were used in calculating Hazard Indexes for each selected site/alternative combination as composite ratios between the estimated species exposures to each of the contaminants and estimated, contaminant-specific toxic levels. A Hazard Index greater than one would indicate a potential for the combined exposures to adversely affect the health of terrestrial species. The maximum estimated dose occurred at LLNL under Regionalized Alternative 2 and led to a maximum estimated Hazard Index of 0.09. This value suggests that the maximum total doses should be less than one-tenth of those of potential concern for ecotoxicity. Therefore, impacts to terrestrial receptor populations from radioisotope emissions from LLW treatment facilities are expected to be minimal. Additional information on the methods used to assess potential toxicity to terrestrial animals, as well as the results of the analysis, is presented in Section C.4.4. of Volume III and the impacts technical report (DOE, 1996a).

7.7.4 Consideration of Sensitive Species

For comparison of the LLW management program's potential to affect sensitive species, Table 7.7–2 lists the numbers of Federal- and state-listed sensitive species occurring or potentially occurring at each LLW site under each alternative. Site-specific analysis would be required to assess sensitive species impacts. That analysis would take into account specific locations for the LLW facilities in relation to the location of sensitive habitats and species at each site, including species listed by the U.S. Fish and Wildlife Service as endangered or threatened.

7.7.5 Effects of Low-Level Waste Transportation

The ecological impacts of a transportation accident involving shipment of LLW were analyzed based on an estimate of a waste spill release rate and stream characteristics for a hypothetical aquatic environment. The impacts of waste transportation accidents were evaluated by ORNL (1995d) as consequence assessments that did not include estimates of the probability of occurrence of these events. The transportation accident scenario analyzed spilling the contents of a rail shipment of LLW from INEL (ANL–W) into surface waters of different sizes. As a result of the packaging used in the transportation of LLW, it was assumed that the

Table 7.7–2. Numbers of Federally Listed and State-Listed Endangered and Threatened Species Occurring or Potentially Occurring at the LLW Sites by Alternative (Federal/State)

Alternative	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T[a]	D																
No Action	10[b]	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	--	--	--	8/8	--
Decentralized		16	2/5	2/6	--	3/11	2/2	2/4	6/5	--	1/11	9/12	5/8	1/9	2/2	1/8	8/8	1/8
Regionalized 1		12	--	--	--	3/11	2/2	2/4	6/5	--	1/11	9/12	5/8	1/9	2/2	--	8/8	--
Regionalized 2	11	12	--	--	2/10	3/11	2/2	2/4	6/5	--	1/11	9/12	5/8	1/9	2/2	--	8/8	--
Regionalized 3		6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	--	--	--	8/8	--
Regionalized 4	7	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	1/9	2/2	--	8/8	--
Regionalized 5	4	6	--	--	--	3/11	2/2	2/4	--	2/2	1/11	--	--	--	--	--	8/8	--
Regionalized 6		2	--	--	--	3/11	--	--	--	--	--	--	--	--	--	--	8/8	--
Regionalized 7		2	--	--	--	3/11	--	--	--	2/2	--	--	--	--	--	--	8/8	--
Centralized 1		1	--	--	--	3/11	--	--	--	--	--	--	--	--	--	--	8/8	--
Centralized 2		1	--	--	--	3/11	--	--	--	2/2	--	--	--	--	--	--	8/8	--
Centralized 3	7	1	--	--	--	3/11	--	2/4	--	--	1/11	--	--	1/9	2/2	--	8/8	--
Centralized 4	7	1	--	--	--	3/11	--	2/4	--	2/2	1/11	--	--	1/9	2/2	--	8/8	--
Centralized 5	1	1	--	--	--	3/11	--	--	--	--	--	--	--	--	--	--	8/8	--

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = no major action proposed at the site under the alternative.

[a] All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are blank.

[b] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

entire contents of the shipments could be released to surface waters following an accident, but that only a small fraction of the release would be soluble.

According to the results of this analysis, an estimated 30,000 curies of radioactivity, including nearly 15,000 curies of Co-60, would be released into surface waters. Such a release would produce adverse impacts on aquatic populations in 385 meters of a second-order stream and in 1 meter of a fourth-order stream; larger streams are expected to be unaffected. DOE also evaluated the potential impacts of the spill under the assumption that all released material partitioned to sediment. Since LLW typically includes a large fraction of insoluble material, this scenario probably is a more accurate model of the potential consequences of a LLW transportation accident. The results of the sediment deposition scenario analysis suggest that more than 2,000 metric tons of sediment could be contaminated to a level requiring remediation. Additional information on the methods used to assess the potential consequences of LLW transportation accidents on aquatic environments, as well as the results of the analysis, is presented in Section C.4.4 of Volume III and the impacts technical report (DOE, 1996a).

7.8 Economic Impacts

LLW facility construction and operations expenditures would substantially benefit the local economy at 6 of the 16 major LLW sites through job or personal income of 1% or greater of the regional baseline under one or more of the alternatives. None of the LLW alternatives would affect the national economy.

DOE estimated the effects of expenditures for LLW management on the local and national economies (see Table 7.8–1). Local economic effects were based on direct expenditures at each site for construction, operation and maintenance, and decontamination of treatment and disposal facilities. The socioeconomic region-of-influence (ROI) where local effects were evaluated, consists of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data for the ROI counties. Local jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at the national level only.

Table 7.8-1. Economic Impacts Analyzed for LLW Alternatives

Economic Impact Analyzed	Affected Aspect of Economy	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional employment multiplier at each LLW site	Table 7.8-2
Increased regional incomes	Regional personal income for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional income multiplier at each LLW site	Table 7.8-2
National economic effects	National economy	Proposed site expenditures plus total transportation expenditures multiplied by national employment and income multipliers	Text discussion only

Local economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined to estimate total project effects at each site. For all alternatives (except No Action), the construction phase at any site was assumed to take 4 years; the operations phase was assumed to take 15 years (a 10-year operations and maintenance period and a 5-year decontamination period). Under the No Action Alternative, in place of distinct construction and operational phases, all costs were assumed to occur in a 20-year workoff of all existing waste (plus 5 years decontamination and decommissioning). Five years were added to both the construction and the operations phases to account for the continued effects on employment and income after each project phase ended. Job and personal income increases are shown for each site in the Volume II site tables.

Across the LLW alternatives, six DOE sites would experience a 1% or greater change in the number of jobs as a result of expenditures (see Table 7.8-2). The Hanford site would experience the greatest increase in the number of direct, indirect, and induced jobs under any of the alternatives, with a maximum increase of 3.3% under the Centralized Alternative 5. Other substantial increases in jobs occur at INEL and LANL under Regionalized Alternative 5, at LANL under Regionalized Alternatives 3 and 4, and at SRS under Regionalized Alternatives 6 and 7. Regionalized Alternative 2 and Centralized Alternative 3 would result in increases of 1% or greater in the number of jobs in five regional economies.

Changes in personal income of 1% or greater occur only at INEL under Regionalized Alternative 5 and at the Hanford site under the Centralized Alternative 5. In general, alternatives that include expenditures for

Table 7.8-2. LLW Jobs and Personal Income (P.I.) as a Percent of Jobs and Personal Income in the Regional Economic Baseline (LLW Sites Where Percentages Are 1% or Greater)[a]

Alternative	Number of Sites		Hanford		INEL		LANL		ORR		PORTS		SRS	
	T[b]	D	Jobs	P.I.	Jobs	P.I.	Jobs	P.I.	Jobs	P.I.	Jobs	P.I.	Jobs	P.I.
No Action	10[c]	6			1.1		1.2		1.1				1.4	
Decentralized		16			1.1		1.3				1.4		1.8	
Regionalized 1		12			1.1		1.6				1.6		1.8	
Regionalized 2	11	12			1.3		1.5		1.4		1.7		1.8	
Regionalized 3		6			1.1		2.1		1.0				1.8	
Regionalized 4	7	6			1.5		2.4		1.6		1.1		1.8	
Regionalized 5	4	6			3.0	1.1	2.2		1.8				1.8	
Regionalized 6		2											2.5	
Regionalized 7		2											2.5	
Centralized 1		1	1.7											
Centralized 2		1												
Centralized 3	7	1	1.5		1.0		1.4		1.3		1.1			
Centralized 4	7	1			1.0		1.4		1.3		1.1			
Centralized 5	1	1	3.3	1.2										

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = Dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. Blank cells equal jobs or personal income growth less than 1%.

[a] Blank cells are less than 1%.

[b] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[c] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

volume reduction at DOE sites would cost more than alternatives that employ only minimum treatment at those same DOE sites. Since economic impacts are linearly proportional to the amount of money spent, the alternatives employing volume reduction treatment would result in larger increases in the number of jobs and personal income.

Comparing the alternatives, the sum of the new direct, indirect, and induced jobs from combined weighted construction and operations and maintenance activities across site ROIs ranges from 9,000 under Centralized Alternative 1 to 18,600 under Regionalized Alternative 2.

In addition to analyzing the impacts on the regional economy, a comparison of these impacts was made on the national economy. None of the LLW alternatives would substantially affect the national economy. The total number of jobs generated in the national economy from combined weighted construction and operations phase activities range from 16,650 under Centralized Alternative 2 to 27,400 jobs under Regionalized Alternative 5. Although the number of jobs appears large in absolute terms, 27,400 jobs represent only 0.02% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. Changes would represent a shift in the source of income from previous employment to employment in LLW projects, rather than a net change in national personal income.

7.9 Population Impacts

Substantial population increases are anticipated at one of five DOE sites under seven of the LLW alternatives, at two sites under Regionalized Alternative 5. These increases could affect community structure and provision of services.

Potential population changes in the ROI at each LLW site were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used as an indicator of the likelihood that such population changes would cause effects, such as changes in community size, stability, diversity, and identity, and effects on the provision of necessary services. Sites identified with potential increases greater than or equal to 1% of the total ROI population are presented in Table 7.9–1.

Table 7.9–1. Percentage Population Increase for LLW Alternatives at Sites Identified With Potential Increases Over 1% of the Current ROI Population

Alternative	Number of Sites		Hanford	INEL	LANL	ORR	SRS
	T[b]	D					
No Action	10[c]	6					
Decentralized		16					
Regionalized 1		12			1.0		
Regionalized 2	11	12					
Regionalized 3		6					
Regionalized 4	7	6			1.4		
Regionalized 5	4	6		3.2		1.0	
Regionalized 6		2					1.3
Regionalized 7		2					1.3
Centralized 1		1					
Centralized 2		1					
Centralized 3	7	1			1.0		
Centralized 4	7	1			1.0		
Centralized 5	1	1	1.5				

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites.
[a] Blank cells indicate that potential increases do not exceed 1%.
[b] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.
[c] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

For No Action and the Regionalized and Centralized minimum treatment alternatives, population in-migrations are not expected to be greater than or equal to 1% at any of the LLW sites, except SRS under Regionalized Alternatives 6 and 7. SRS would experience population increases of 1.3% and thus some impact to community characteristics and the provision of services may be anticipated. Under the Decentralized Alternative, LANL would experience a 1% population increase.

For those alternatives based on treatment by volume reduction, the Hanford site under the Centralized Alternative 5; INEL under Regionalized Alternative 5; LANL under Regionalized Alternative 4 and Centralized Alternatives 3 and 4; and ORR under Regionalized Alternative 5 would have population increases greater than or equal to 1%. Only one volume reduction alternative, Regionalized Alternative 2, has no sites with major population increases. One site is affected by more than one volume reduction alternative—LANL under Regionalized Alternative 4 and Centralized Alternatives 3 and 4. INEL and ORR are affected only under Regionalized Alternative 5. Some minor impact may also be expected at the Hanford Site and SRS under Regionalized Alternatives 2, 4, and 5 and at ORR and Portsmouth under Regionalized Alternative 2.

All site population increases including those less than 1% are shown in Volume II site data tables.

7.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of LLW indicated that, with the exception of low-income populations at PORTS, minority and low-income populations at the LLW sites would not experience disproportionately high and adverse health risks or environmental impacts under most of the LLW alternatives.

Analysis of environmental justice impacts from management of LLW was based on a review of the impacts reported in this chapter regarding the LLW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the 16 major LLW sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done, and the maps illustrating the distribution of minority and low-income populations within 50 miles of each LLW site.

7.10.1 Results

The potential for adverse human health effects from exposures to radionuclide emissions from LLW treatment facility operations is low for most LLW management alternatives. Incident-free LLW treatment facility operations were analyzed (see Section 7.4.1) in terms of risk to workers and the public. Overall, at most sites, incident-free operations present no significant risk and do not constitute a reasonably foreseeable adverse impact to the surrounding populations.

Screening criteria for the nonworker MEI (see Appendix C) indicated a cancer fatality probability of 1.0E–06 or greater for facility operations at FEMP under Regionalized Alternative 2; at Hanford under Regionalized Alternatives 4 and 5 and Centralized Alternatives 4 and 5; at LLNL under Regionalized

Alternative 2; at ORR under Regionalized Alternative 5; and at PORTS under Regionalized Alternative 4 and Centralized Alternative 3. However, demographic analysis of the five ROIs (FEMP, Hanford, LLNL, ORR, PORTS) indicated that only at PORTS would the MEI be located in a minority or low-income census tract. At PORTS (under the Regionalized 4 and Centralized 3 Alternatives), the MEI would be located in a census tract with a low-income proportion (32.7%) that exceeds the national average (13.1%).

A more detailed analysis of environmental justice impacts would be included in NEPA documents that deal with site-specific activities. The number of potential fatalities due to both radiological and nonradiological exposures to truck or rail transportation of LLW is small.

7.10.1.1 Transportation

Because incident-free LLW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income populations, no environmental justice impacts are expected from transportation. As Section 7.4.2 indicates, total fatalities programwide to the collective population (all individuals within 0.5 mile of the transportation corridors) resulting from incident-free transportation range from less than 0.5 fatality to 12 fatalities or approximately 1 fatality for each 47 million shipment miles. This small number of collective population fatalities is spread across a large number of shipments. A disproportionate share of minority and low-income populations reside near interstate highways and railroads; however, the major routine risks to the public from truck transportation are from exposure during rest stops to travelers who are at the same rest stops. Minority and low-income populations are found to be disproportionately lower in representation at highway rest stops (DOT, 1992). For rail shipments, the primary risks to the public are from radiological exposure during railcar classification in railyards, primarily at the start and end of each shipment, and from the emission of diesel exhaust from the trains in urban areas. Even for the individuals expected to be exposed most frequently—residents near a site entrance, individual cancer fatality risk was only minimally elevated. This is true even at sites such as the Hanford Site and NTS, which handle 240,000 to 260,000 shipments (about 100 shipments per operational day) under various Centralized Alternatives during the 10-year operations period. Because the risks to these MEIs were found to be minimal (about 2 in 1 million), no segment of the population anywhere in the transportation corridors is expected to be at high risk. Therefore, no disproportionately high and adverse health effects to minority or low-income populations from incident-free LLW transportation are expected to occur.

The expected number of cancer fatalities due to radiation exposure from transportation accident releases, taking into account both the consequences of such a release and the probability that such a release will occur, is less than 0.5 under all alternatives. Estimated transportation accident fatalities from physical injuries range from less than 0.5 under the No Action Alternative to 35 under the Centralized Alternative 1 (approximately one fatality per 16 million shipment miles).

7.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 7.10.1 did not indicate any adverse impacts to water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Air quality impacts are possible at two sites, but no disproportionately high and adverse impacts are expected for any segment of the population.

None of the LLW management alternatives would have an adverse impact on land use, ecology, or cultural resources because of the limited amount of previously undisturbed land that would be needed for use onsite (no offsite lands are involved) and mitigation programs already in place. Because reasonably foreseen environmental impacts, if any, to land use, ecological resources, or cultural resources are expected to be small under any of the alternatives, DOE expects no disproportionately high and adverse environmental impacts to minority and low-income populations at the LLW sites.

7.11 Land Use Impacts

Land requirements for LLW facility construction are minimal at most sites under the LLW alternatives. However, under several alternatives, land requirements at FEMP, Hanford (under Centralized Alternative 5), ORR, Portsmouth, and WVDP would exceed 1% of land designated or suitable for waste operations. Further evaluation of these sites indicated no impacts are expected to current onsite land uses and no conflicts with offsite uses are expected. Review of site development plans indicated no conflict between proposed treatment or disposal facilities and other plans for the major sites.

DOE evaluated the impacts of the alternatives on land use by comparing the acreage required for new treatment and disposal facilities to the acreage either designated for waste operations or suitable for development (Table 7.11–1). Suitable land is the total site acreage, minus the acreage required for existing

Table 7.11-1. Land Use Impacts Analyzed for the LLW Alternatives

Land Use Impact Analyzed	Affected Land Use	Analysis Method	Presentation of Results
Effect on land use onsite at each LLW site	Land use shown in site development plans	Comparison of required land area with amount designated (or estimated land) for LLW plan—all instances where requirements are 1% or higher are noted.	Table 7.11-2
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed WM uses and nearby land uses.	Text discussion only

structures and roads, known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts between the proposed facilities required under each alternative and plans for future site uses.

The land requirements analysis indicated that for the majority of LLW sites under all the LLW alternatives, land required to build treatment, storage, and disposal facilities is less than 1% of designated or suitable site land. Sites where the facility land requirements constituted 1% or more of designated or suitable acreage are listed in Table 7.11-2. The land use requirements exceed 1% of site land at WVDP under all alternatives. With the single exception of WVDP under the Decentralized Alternative, none of the other sites would be expected to exceed 3% of the total available land area. Because the analysis showed that LLW facilities would require only a small portion of the designated or suitable land at these sites, no land impacts onsite are expected. For the same reason, no conflicts with adjacent land uses are expected.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations within a site. Should a sitewide or project-level NEPA review indicate that a site is not suitable for a waste management facility because of land use considerations that cannot be avoided or mitigated, then DOE will reconsider its decision to locate a waste management facility at that site.

Table 7.11–2. Percent of Waste Management-Designated or Suitable Land Required for LLW Facility Construction at Sites Where the Requirement is 1% or Greater [a]

Alternative	Number of Sites		FEMP	Hanford	ORR	PORTS	SNL-NM	WVDP
	T[b]	D						
No Action	10[c]	6	--		1.5	--	--	2.4
Decentralized		16	--		1.4	--	1	10.9
Regionalized 1		12	--		1.4	1.4	--	2.4
Regionalized 2	11	12	1.4			1.4	--	2.4
Regionalized 3		6	--		2.4	--	--	2.4
Regionalized 4	7	6	--		1.4		--	2.4
Regionalized 5	4	6	--		1.5	--	--	2.4
Regionalized 6		2	--		--	--	--	2.4
Regionalized 7		2	--		--	--	--	2.4
Centralized 1		1	--		--	--	--	2.4
Centralized 2		1	--		--	--	--	2.4
Centralized 3	7	1	--				--	2.4
Centralized 4	7	1	--				--	2.4
Centralized 5	1	1	--	1.4			--	2.4

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = No major actions are proposed at the site under the alternative.
[a] Blank cells indicate a requirement of less than 1%.
[b] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.
[c] Ten sites use existing facilities for Volume Reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

7.12 Infrastructure Impacts

Proposed LLW activities would affect onsite infrastructure at 13 of the major sites, although no offsite infrastructure impacts are expected. New requirements for water, wastewater treatment, or electrical power for proposed LLW facilities equal or exceed 5% of current system capacity at seven sites. Hanford Site and WVDP would approach or exceed the total site wastewater treatment capacity (new requirement plus current treatment load) in the alternatives where Hanford accepts offsite waste for treatment and disposal and in the Decentralized Alternative for WVDP. At WVDP, power and water requirements exceed the total capacity of the current system. Wastewater requirements for all other alternatives for WVDP exceed the current capacity. Twelve sites experience employment increases of 5% or more of current site employment during construction which could lead to traffic increases that would affect onsite transportation infrastructure.

DOE evaluated impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and electrical power (See Table 7.12–1). Water and power were evaluated

Table 7.12–1. Infrastructure Impacts Analyzed for the LLW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support LLW facilities	Capacity of onsite water, power, and wastewater systems	Add increased LLW facility use to current use and compare to current capacities	Table 7.12–2
	Onsite transportation infrastructure	Compare new site employment with current site employment as an index of increased stress	Table 7.12–3
Capacity of community infrastructure to support increased worker populations and their families	Regional water, power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion only

for both construction and operations; wastewater treatment was evaluated only for operations because wastewater from construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to the onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on the community infrastructure.

Table 7.12–2 shows the increase in onsite demand for water, wastewater treatment, and electrical power at sites where the increase exceeds 5%. The potential for a major impact is assumed to exist where an increase of 5% or greater causes total demand to exceed 90% of capacity. A moderate impact is assumed possible where total demand remains below 90% of capacity. Impacts to offsite infrastructure are not expected because population increases do not exceed 5% at any site under any alternative.

As shown in Table 7.12–2, most of the infrastructure impacts relate to demand for wastewater treatment and power. Major wastewater treatment impacts would occur at the Hanford Site under Centralized Alternatives 3 and 5 and at WVDP under the Decentralized Alternative. For the Decentralized Alternative at WVDP, the new demands would exceed 90% of the capacity for all three resources. Because WVDP is currently using full capacity of the wastewater system, all alternatives will impact the treatment system infrastructure.

Table 7.12–2. Increase in Demand for Water, Wastewater, or Power as a Percent of Current Capacity—LLW Sites With Increases Exceeding 5%

Alternative	Number of Sites T[a]	Number of Sites D	ANL-E	Hanford	INEL	NTS	ORR	SRS	WVDP
No Action	10[b]	6		Ww (6.6)					W (5.8) P (10.7)
Decentralized		16	P (7.4)		P (5.8)	--	P (5.6)		W (53.45) Ww (8.03) P (130.63)
Regionalized 1		12			P (5.8)	--	P (5.6)		W (5.8) P (10.7)
Regionalized 2	11	12		Ww (5.5)	P (7.1)	--			W (5.8) P (10.7)
Regionalized 3		6			P (5.8)		P (12.2)		W (5.8) P (10.7)
Regionalized 4	7	6		Ww (5.7)	P (7.2)		P (5.7)		W (5.8) P (10.7)
Regionalized 5	4	6		Ww (5.7)	**P (17.5)**		P (6.0)		W (5.8) P (10.7)
Regionalized 6		2		Ww (6.3)		--		Ww (5.4) P (5.6)	W (5.8) P (10.7)
Regionalized 7		2						Ww (5.4) P (5.6)	W (5.8) P (10.7)
Centralized 1		1		**Ww (8.26)** **P (6)**		--			W (5.8) P (10.7)
Centralized 2		1				P (12.3)			W (5.8) P (10.7)
Centralized 3	7	1		**Ww (15.9)** **P (6.3)**	P (7.2)	--			W (5.8) P (10.7)
Centralized 4	7	1			P (7.2)	P (7.6)			W (5.8) P (10.7)
Centralized 5	1	1		**Ww (50.8)**		--			W (5.8) P (10.7)

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = No major actions are proposed at the site under the alternative. Bold indicates major impact; all others are moderate. W = water; Ww = wastewater; P = power. Blank cells indicate an increase of 5% or less of current capacity.

[a] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

Table 7.12-3 identifies sites where the increase in site employment from construction activities exceeds 5%. These sites could experience impacts to the onsite transportation infrastructure from increased worker traffic. The Decentralized Alternative at WVDP would have an increase of approximately 41% for the site employment due to construction activities, which is the largest increase in site employment for the LLW waste management activities.

Table 7.12-3. Percent Increase in Site Employment From Construction—LLW Sites With Employment Increases Equal to or Greater Than 5%

Alternative	Number of Sites		FEMP	Hanford	INEL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SRS	WVDP
	T[a]	D												
No Action	10[b]	6	--						5	--	7	--	--	13
Decentralized		16	--			24	--	10	16		16		22	41
Regionalized 1		12	--			7	--		16		16		22	13
Regionalized 2	11	12	11		5	10	--	8	24		29	8	19	13
Regionalized 3		6	--			8	--	5	7	5		--	22	13
Regionalized 4	7	6	--		5	17		9	7	5	20	6	19	13
Regionalized 5	4	6	--		23	5		10	7	5		--	19	13
Regionalized 6		2	--	5	--	--			7	5		--	36	13
Regionalized 7		2	--		--	--	14		7	5		--	36	13
Centralized 1		1	--	9	--	--	--	--	7	5		--		13
Centralized 2		1	--		--	--	26	--	7	5		--		13
Centralized 3	7	1	--	9		13	--	7	7	5	20	7		13
Centralized 4	7	1	--			13	8.6	7	7	5	20	7		13
Centralized 5	1	1	--	20	--	--	--	--	7	5		--		13

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = Dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites. -- = No major action proposed for the site under the alternative. Bold indicates major impact; all others are moderate. Blank cells indicate site employment increases of less than 5%.

[a] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

7.13 Cultural Resources Impacts

Construction and operation of LLW facilities could adversely affect cultural resources. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where LLW treatment and disposal facilities are proposed to be built. Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys at the 16 major proposed LLW sites and lists the reported cultural resources at those sites. However, the impacts of the construction of LLW facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Land requirements for the construction of LLW waste management facilities are sufficiently small under all alternatives so that DOE would probably have enough flexibility in siting LLW facilities to avoid impacts on cultural resources. If not, measures would be taken to mitigate negative effects on these resources.

7.14 Costs

Costs decrease as the number of treatment and disposal sites decrease, ranging from $17 to $11 billion for minimum treatment, and from $20 to $15 billion for volume reduction treatment. At the alternative level, the increased cost of volume reduction treatment more than offsets the disposal savings achieved from reduced volume. Transportation costs are lower than facility costs, making shipment to available facilities at another site generally less expensive than building new onsite facilities.

Table 7.14–1 outlines the cost-analysis components that DOE used to estimate costs for building and operating LLW treatment and disposal facilities and for transporting LLW (INEL, 1995a,b). DOE evaluated costs associated with LLW management from both a life-cycle and process perspective, using 1994 dollars.

7.14.1 LIFE-CYCLE COST

DOE evaluated facility costs for four phases representing the life-cycle of the facilities and their operations: preoperations, construction, O&M, and decontamination and decommissioning. Life-cycle costs do not include speculative factors, such as impacts on the long-term value of land.

Costs for preoperation activities consist of technology and site adaptation, including bench-scale tests and demonstrations; permitting; plant startup and cold run costs; and related conceptual design, safety analysis, project management, and contingencies.

Facility construction costs consist of building construction, equipment purchase and installation, contractor overhead, and related design, construction management, project management, and contingencies. Mobilization and demobilization costs are included for portable treatment units.

Table 7.14–1. Components of Cost Analysis

Impacts Assessed	Functions Analyzed	Activities for Which Impacts Were Assessed	Location of Impacts Assessment
Process Costs	Treatment[a]	Life-cycle costs for treatment including support facilities; estimated for minimum treatment and volume reduction	Table 7.14–2
	Storage	No life-cycle costs for storage facilities were estimated; on-site storage was assumed to be adequate	Not applicable
	Disposal[b]	Life-cycle costs for disposal facilities	Table 7.14–2
Transportation Cost	Truck	Inter-site common carrier costs for transportation from generating sites to treating sites, and to disposal sites	Table 7.14–2
	Rail	See above	Table 7.14–2

[a] No Action Alternative includes 20 years of treatment at the current mix of minimum treatment and volume reduction per site capabilities.
[b] Disposal includes closure and 300 years of postclosure custodial support.

Operations and maintenance costs consist of annual operations labor and material, maintenance labor and equipment, utilities, contractor supervision and overhead, and related project management and contingencies.

Decontamination and decommissioning costs consist of facility decontamination and demolition, closure, post-closure, and environmental monitoring activities.

7.14.2 Process Cost

DOE also analyzed costs for treatment, storage, and disposal activities. Treatment costs include costs to build and operate treatment facilities (such as incineration) and common support facilities (such as maintenance and certification/shipping facilities). For the No Action Alternative, DOE estimated the costs of a mix of minimum treatment and volume reduction, as accomplished currently by the sites. For the Decentralized Alternative, Regionalized Alternatives 1, 3, 6, and 7, and Centralized Alternatives 1 and 2, DOE estimated the costs of minimum treatment (solidification of liquids and fines as required to transport or for disposal). For Regionalized Alternatives 2, 4, and 5, and for Centralized Alternatives 3, 4, and 5, DOE estimated the cost of volume reduction (incineration, shredding, supercompaction, and follow-on solidification) at various combinations of regional treatment sites.

For the purpose of the WM PEIS analysis, existing LLW storage capacity is assumed to be sufficient for all alternatives. DOE assumed that after being treated, the waste would be disposed of in a timely manner. The minimal costs for storage were not estimated separately.

Disposal costs include costs to build and operate front-end administration and receiving facilities for disposal as well as the actual disposal units.

Transportation costs include the costs associated with the physical movement of the waste from one site to another, for either treatment or disposal. Transportation costs are evaluated for both truck transportation and rail shipments (INEL, 1995a).

Support facilities were assumed to be available for the No Action Alternative but were assumed to require construction for the other alternatives. Packaging and certification/shipping facilities were assumed to require construction in each alternative because of their critical role in the proper control and tracking of waste, and because an inventory of existing support facilities was not available.

The summary of costs is shown in Table 7.14–2 (INEL, 1996). Construction accounts for 15% to 33% of the total costs, and O&M accounts for 49% to 72% of those costs. As waste is consolidated at fewer sites, costs for treatment and disposal facilities decrease, reflecting the economy of scale of using larger and fewer facilities. In considering minimum treatment, the reduction in cost between the Decentralized Alternative and Centralized Alternative 2 is $5.7 billion; the reduction is in disposal costs, partially offset by $2.2 billion of increased transportation costs. For volume reduction, the decrease in cost between Regionalized Alternative 2 and Centralized Alternative 5 is $4.2 billion. This is potentially offset by increased transportation costs of approximately $2.4 billion. Volume reduction treatment costs are twice as high as minimum treatment costs, and more than offset savings achieved in lowered disposal costs from less waste being disposed.

Although the quantity of waste requiring transport is at its maximum in the alternatives that centralize functions at NTS or the Hanford Site, the relative proportion of transportation costs remains relatively small, less than 21% of total costs. For the decentralized and regionalized alternatives, transportation costs are less, ranging from 0.1% to 5% of total costs.

7.15 Environmental-Restoration-Transferred Waste

The volume of LLW generated by environmental restoration activities that would be transferred to the waste management program is currently estimated to be about 140% of the volume of waste management LLW requiring treatment. The radiological profiles and physical characteristics of the environmental restoration (ER) transferred LLW have not yet been determined to the extent necessary to allow a meaningful evaluation of the potential environmental and human health impacts. The potential effects resulting from the treatment of the ER transferred LLW within the waste management program are discussed separately in the WM PEIS. When the radiological and physical characteristics of the ER transferred waste are better known, DOE may be required to assess the impacts of managing the ER transferred LLW on a site-specific basis.

Table 7.14-2. Life-Cycle Costs (billions of 1994 dollars)

Alternatives	Number of Sites		Total Costs[a] (Including Truck Transportation)	Life-Cycle Costs				Process Costs[b]		Transport Costs	
	T[c]	D		Preops	Const	O&M	D&D	T	D	Truck	Rail
No Action	10[d]	6	18.1	0.32	3.54	13.11	1.08	7.06	11.1	0.07	0.14
Decentralized		16	16.8	1.24	4.66	9.47	1.42	5.85	10.95	0.05	0.02
Regionalized 1		12	16.4	1.24	4.43	9.32	1.34	5.89	10.43	0.06	0.02
Regionalized 2	11	12	19.5	1.65	4.75	11.92	1.16	12.73	6.78	0.06	0.02
Regionalized 3		6	14.9	1.02	4.91	7.73	1.00	5.96	8.71	0.23	0.07
Regionalized 4	7	6	19.8	1.6	4.77	12.04	1.14	13.4	6.2	0.22	0.07
Regionalized 5	4	6	19.7	1.48	4.87	11.94	1.08	12.8	6.57	0.34	0.08
Regionalized 6		2	13.0	0.99	4.08	6.50	0.77	6.31	6.03	0.65	0.17
Regionalized 7		2	13.9	0.98	4.08	7.60	0.61	6.31	6.95	0.67	0.18
Centralized 1		1	12.2	0.77	1.89	6.02	1.09	6.47	3.3	2.46	0.44
Centralized 2		1	11.1	0.70	1.88	5.50	0.79	6.45	2.42	2.25	0.43
Centralized 3	7	1	18.2	1.39	3.14	10.47	0.94	13.3	2.57	2.34	0.43
Centralized 4	7	1	17.3	1.33	3.14	9.74	0.94	13.3	1.82	2.15	0.43
Centralized 5	1	1	15.3	1.08	2.59	8.17	0.98	10.23	2.57	2.45	0.43

Notes: Preops = preoperations; Const = construction; O&M = operations and maintenance; D&D = decontamination and decommissioning. T = treat; "treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose; each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites.

[a] Total Facility Costs are presented twice in this table: as life-cycle costs and as process costs. The sum of life-cycle costs is equal to the sum of process costs. Total Costs, also in the table, add truck costs to the facility costs. Therefore, Total Costs equals the sum of life-cycle costs and truck costs and also equals the sum of process costs and truck costs.

[b] Since sites are routinely treating/packaging and shipping to disposal sites, the current storage is included in the site infrastructure accounts which are not included in this PEIS.

[c] All sites do "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[d] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites above include volume reduction facilities.

DOE is responsible for the management of wastes currently in inventory and those generated by future operations (referred to as "waste management" wastes). As discussed in Chapter 1, DOE is also responsible for the management and remediation of contaminated media including soils, groundwater, and buildings. DOE expects that most of the contaminated media at its DOE sites will be remediated under the Environmental Restoration Program. The extent to which media are "cleaned up" is site specific and will depend largely on regulatory requirements and decisions regarding future land use. For analytical purposes, a standard "base case" scenario has been developed that estimates remediation costs across the DOE complex (DOE, 1996c). Although most waste generated by cleanup activities will be managed within the Environmental Restoration Program, a certain subset of the waste generated by these remediation activities will be transferred to waste management facilities. In the WM PEIS, these wastes are referred to as "environmental restoration (ER) transferred wastes." At present, only estimates of the volumes of ER transferred waste are available. These estimates were used to provide a qualitative assessment about how the addition of ER transferred waste may affect LLW alternatives.

Appendix B provides more detail on how certain wastes generated during environmental restoration will be transferred to the waste management program for final disposition and provides estimates of the volumes of ER transferred LLW. Appendix B also discusses the assumptions and uncertainties involved in assessing how ER transferred LLW may affect waste management alternatives.

To conduct an impact analysis for the additional ER transferred LLW similar to that conducted for waste management LLW, additional information is needed on the ER transferred waste streams. In addition to the volume of ER transferred waste, information is needed on the treatability characterization of the individual transferred LLW streams, including data about the radiological profile, chemical constituents, and physical form of the ER transferred waste. The wastes would also have to be categorized according to alpha and non-alpha radionuclide composition. Physical characterization of the ER transferred wastes into one of the treatment categories identified for TRUW is needed to estimate management costs. Information about the timing for the transfer of ER wastes to the waste management program is needed to determine the capacities of treatment or disposal facilities. This information is also crucial to conduct transportation and socioeconomic analyses. However, in many cases, this information will not be available until site-specific cleanup is conducted.

To identify how the addition of ER transferred LLW could affect the comparison among waste management alternatives made in the WM PEIS, DOE compared the volumes of waste management LLW with the expected volumes of ER transferred LLW. This analysis reveals the potential for overloading treatment facilities for those sites and alternatives where the volumes of ER transferred LLW are projected to equal or exceed the volumes of waste management LLW. Strategies that can be used to manage the additional loading of ER transferred LLW in order to avoid overloading facilities include increasing facility operational capacity and operating a facility longer to "work off" the increased waste load. The WM PEIS treatment facilities are assumed to have an effective operational life of at least 30 years, which allows for an additional 20 years of operational capacity beyond the 10 years needed to work off the waste management wastes.

Increased radiation and chemical exposure risks to site workers, offsite populations, and the environment are related to the radiological activity in the ER transferred wastes, which at present cannot be reliably predicted. However, because radiological activities and chemical concentrations in ER transferred waste are, in general, expected to be lower than those for comparable waste management waste, risks from the addition of ER transferred wastes are expected to be lower than the risks resulting from the treatment of equivalent volumes of waste management wastes. In addition, because most ER transferred LLW (e.g., soils and debris) is expected to be amenable to the minimal treatment (e.g., packaging or solidification) criteria to meet LLW disposal requirements rather than to the full volume reduction treatment, risks and impacts to offsite populations are expected to be comparable or lower than those for similar types of waste management LLW. Site-specific performance assessments would be conducted, and appropriate disposal restrictions would be imposed to manage any potential increased risks. The risks from physical hazards associated with operating facilities to manage the ER transferred waste are related to the volume relationship between the ER transferred and waste management wastes. Transportation risks and costs are also dependent on waste volumes rather than the composition of the waste.

Overall, the volume of ER transferred LLW is expected to be about 127% of the waste management LLW load (1,900,000 cubic meters compared with 1,500,000 cubic meters, respectively; see Table B.6-1). The additional ER transferred LLW would exceed the waste management LLW load at five sites (ANL-E, FEMP, INEL, NTS, and SNL-NM) under the Decentralized Alternative (see Table B.7-1). The additional ER transferred LLW would be 130% of the waste management load at ANL-E and would represent a 130% increase to the INEL LLW load. The large increase in ER transferred LLW at NTS and SNL-NM (650× and 14× the respective WM LLW loads) would require increased capacity for the minimal LLW treatment facility, along with a longer period of operation. Because the bulk of the ER transferred LLW would require minimal treatment at most sites, the effects of the additional ER transferred waste loads at

NTS and SNL-NM in the Regionalized Alternatives would be small. Using the minimal treatment option, the additional ER transferred LLW would also be expected to influence the Centralized Alternative. The large input of ER transferred LLW at FEMP (180,000 cubic meters compared to 0 for waste management LLW) is due to the fact that FEMP is considered an ER site, and thus all waste at the site is, by definition, ER waste. The ER transferred LLW at FEMP is designated for offsite disposal.

7.16 Comparison of Alternatives Summary

The LLW impacts were evaluated across all the LLW alternatives to identify trends and ultimately the preferred alternative. The following discussion focuses on each impact area, identifying alternative trends when appropriate, and highlighting noteworthy findings at particular sites.

Health Risks. For routine treatment, radiation exposure risks to offsite and noninvolved worker populations correlate most closely to the choice of treatment technology (volume reduction risks are 4-20 times higher than those for minimum treatment). Secondarily, the presence of particular sites and waste characteristics in the alternative influences risks. FEMP, Hanford, LLNL, ORR, and Portsmouth experience the highest offsite risk under volume reduction alternatives that consider thermal treatment of tritium-contaminated waste. The number of worker fatalities is about one order of magnitude higher than for other receptors, driven by physical hazards. The increase in treatment worker fatalities as a result of volume reduction treatment operations exceeds the decrease in disposal worker fatalities from handling smaller disposal volumes. Concentrations of radionuclides in groundwater exceed applicable standards at several sites, demonstrating the need for upgraded waste acceptance criteria and other site-specific considerations. Management of radionuclide concentrations and waste forms would be required to assure acceptable water quality and human health risks. One of the most prevalent causes of these exceedances was unconstrained disposal of uranium-238-containing wastes at Hanford and SRS, which was evaluated under most of the alternatives. Disposal of LLW containing uranium-238 must be carefully managed at these sites. In addition, radionuclide exceedances in groundwater were recorded for unconstrained disposal at SNL-NM in the Decentralized Alternative and at Paducah in Regionalized Alternative 2. All other sites meet groundwater standards based on the technical and wasteload assumptions used for the WM PEIS analysis.

The greatest potential consequences for facility accidents occur at sites treating wastes with high concentrations of radioactivity. Only three sites, LLNL, LANL, and Hanford, experience one or more fatalities for accidents evaluated in the WM PEIS.

Transportation risks are proportional to vehicle-miles traveled; consequently, the large volumes of LLW transported in the centralized alternatives lead to relatively high numbers of expected fatalities from both traffic accidents and radiation exposure. Rail accident nonradiological risks are lower than those for truck.

Air Quality Impacts. The management of LLW does not affect the air quality at most sites. However, decentralized treatment and disposal at BNL or centralized disposal at NTS could cause adverse air quality impacts requiring additional emission control measures for criteria pollutants. Emissions of radionuclides were estimated to be below the applicable standards at any site.

Water Resources Impacts. Major impacts to water availability from increased water use at the sites are unlikely, although there is the potential for adverse impacts at LLNL Site-300 and WVDP. As discussed in Section 7.4.1.7, management of radionuclide concentrations from disposal at the Hanford Site, SRS, SNL-NM, and Paducah may be necessary to protect groundwater resources.

Ecological Resources, Cultural Resources, Environmental Justice Concerns, and Land Use. The WM PEIS analysis did not provide discriminators among the alternatives in these four impact areas. The programmatic analysis that was conducted did not reveal any major impacts in any alternative. However, impacts to ecological and cultural resources are dependent to some degree on specific technologies and their location at each site. These were not determined at the programmatic level of the WM PEIS, and these impact areas would be evaluated in more detail when such site-level details are evaluated. Land use is not a discriminator because the LLW alternatives do not use much land compared to the amount available at every site. Assessment of potential environmental justice impacts indicated that with the exception of low-income populations at PORTS, minority and low-income populations at the LLW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the LLW alternatives.

Economic Impacts. Regional economies at six of the 16 major sites would benefit more substantially in jobs expected, in addition to the increased employment at the Hanford Site expected under all the LLW alternatives. None of the LLW alternatives would affect the national economy.

Population Impacts. Generally, the more sites considered in an alternative, the lower the level of impacts at the most affected sites. As waste is consolidated at fewer sites, effects at the shipping sites diminish but effects at the receiving sites and in the transportation corridors increase. The largest increases are evident at INEL under Regionalized Alternative 5 for treatment and disposal.

Infrastructure Impacts. Proposed LLW activities would affect onsite infrastructure at 13 of the major sites, although no offsite impacts are expected. New requirements for wastewater treatment or electrical power for proposed LLW facilities equal or exceed 5% of current system capacity at seven sites. The most significant increases are at INEL in Regionalized Alternative 5 (when volume reduction and disposal are regionalized at the site), at the Hanford Site (Centralized Alternatives 1, 3, and 5) when disposal is consolidated at these sites, and at WVDP (all alternatives). Increased wastewater inputs at Hanford could cause wastewater treatment capacity to be exceeded. For the Decentralized Alternative at WVDP, water, wastewater, and power requirements would exceed the current capacity. Because WVDP is already operating at capacity for wastewater, requirements for all the alternatives will impact the site's wastewater system. Twelve sites would experience employment increases of 5% or more of current site employment during construction, which could lead to traffic increases that would affect the onsite transportation infrastructure.

Costs. Costs decrease as the number of treatment and disposal sites decrease, ranging from $17 to $11 billion for minimum treatment, and $20 to $15 billion for volume reduction treatment. At the national level, the increased cost of volume reduction treatment more than offsets the disposal savings achieved from reduced volume. Transportation costs are lower than facility costs, making shipment to available facilities at another site generally less expensive than building new onsite facilities. The reason for pursuing both privatization and commercialization is the belief that private vendors may be able to perform the same tasks faster and at a lower cost than DOE, through innovative technology, efficient oversight, and application of other streamlined business practices. In the experience of other institutions that have attempted privatization, savings are more common than increased costs. Actual cost differences have not been calculated for this document for the privatization of DOE waste management activities. The details of cost estimating are covered in Section 5.3.3 in Volume I.

Summary of Impacts by Alternative. Tables 7.16–1 and 7.16–2 summarize key impacts for each alternative.

The Preferred Alternative for Treatment. Each site with LLW would treat its waste onsite. Each site would perform minimum treatment on its wastes to prepare them for disposal, although DOE would allow each of its sites the flexibility to perform additional treatment if it would decrease costs and requirements for transportation by significantly reducing the volume of LLW requiring disposal. The potential environmental impacts of all alternatives for treatment of LLW evaluated in the WM PEIS are small. The impacts of DOE's preferred alternative for LLW are identified in Regionalized Alternative 3 as shown in Table 3.7–1 in Chapter 3, under which the potential impacts associated with minimum treatment of LLW at each site were analyzed, assuming regionalized disposal, as discussed below.

The Preferred Alternative for Disposal. The Department's preferred alternative at this time is to send its LLW to regional disposal sites after it is treated. After consultations with stakeholders, the Department intends to select two or three sites from the following six: Hanford, INEL, LANL, NTS, ORR, and SRS.

The six sites named above are those at which DOE already has established LLW disposal operations and, except for NTS, each has large waste volumes for disposal. Because these six sites would have more than adequate capacity for the amounts of LLW the Department will need to dispose of, there is no need to establish additional sites. Fewer than the six sites would provide adequate capacity at a substantially lower overall cost. Relying on only one disposal site, however, would require the most transportation of the waste, with correspondingly higher traffic accident fatalities, and would be operationally inflexible if disposal activities were interrupted.

While all six current disposal sites remain candidates for future disposal operations and the potential health and environmental impacts of regionalized disposal are small, further consideration of various factors may affect the DOE's site preferences. For example, hydrological characteristics indicate that disposal at sites with high rainfall, such as ORR and SRS, would require mitigation costs that would not be needed at more arid sites. However, a disposal configuration that included at least one eastern site and one western site would require less transportation and produce fewer fatalities from traffic accidents than an eastern-only or western-only configuration. Preliminary cost analyses indicate that regional disposal at ORR, LANL, and INEL may not be as cost effective as disposal at SRS, NTS, and Hanford.

Table 7.16-1. Comparison of LLW Alternatives—Projected Risks Results

Alternative	Number of Sites		Treatment Worker Physical Hazard Fatalities	Treatment Worker Cancer Fatalities	Offsite Population Cancer Fatalities	Disposal Worker Physical Hazard Fatalities	Disposal Worker Cancer Fatalities	Groundwater Impacts from Disposal			Truck Radiation Fatalities	Truck Non-Radiation Fatalities
	T[a]	D						Number of Sites That Meet Standards Without Additional Constraints	Number of Sites That Require Additional Constraints to Meet Standards	Radionuclides That Must Be Constrained for Sites to Meet Standards		
No Action	10[b]	6	3	1	*	4	3	4	2	U-238	5	12
Decentralized		16	2	1	*	6	2	12	3	Pu-239, Pu-240, Tc-99, U-234, U-238	*	1
Regionalized 1		12	2	1	*	6	3	9	2	U-238	*	1
Regionalized 2	11	12	4	1	1	4	2	8	3	U-238, Np-237	*	1
Regionalized 3		6	2	1	*	5	3	4	2	U-238	2	3
Regionalized 4	7	6	4	2	*	4	2	4	2	U-238	2	3
Regionalized 5	4	6	4	2	*	4	2	4	2	U-238	2	4
Regionalized 6		2	2	1	*	6	2	0	2	U-238	4	10
Regionalized 7		2	2	1	*	6	1	1	1	U-238	4	10
Centralized 1		1	2	1	*	1	3	0	1	U-238	16	37
Centralized 2		1	2	1	*	1	2	1	0	--	15	38
Centralized 3	7	1	4	1	*	1	2	0	1	U-238	15	35
Centralized 4	7	1	4	1	*	[illegible]	2	1	0	--	14	37
Centralized 5	1	1	4	2	*	1	2	0	1	U-238	15	37

Notes: T = treat; D = dispose. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. * = greater than 0 but less than 1.

[a] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites include volume reduction facilities.

Table 7.16–2. Comparison of LLW Alternatives—Selected Impacts

Alternative	Number of Sites		Number of Sites With Air Pollutants That Exceed Standards	Highest Air Pollutant Percentages at Any Site	Cost ($Billions)	Truck Shipments	Comment
	T[a]	D					
No Action	10[b]	6	0	67 (CO-NTS)	18.1	87,000	Current Program
Decentralized		16	1	100 (NO_2-BNL)	16.8	24,000	Expand from 6 current disposal sites to 16
Regionalized 1		12	0	88 (NO_2-PGDP)	16.4	26,000	Expand from 6 current disposal sites to 12
Regionalized 2	11	12	0	81 (NO_2-PGDP)	19.5	26,000	Volume reduce at 6 western, 5 eastern sites; expand from 6 current disposal sites to 12
Regionalized 3		6	0	47 (NO_2-ORR)	14.9	84,000	Disposal at 6 current sites, but ship based on proximity
Regionalized 4	7	6	0	55 (NO_2-RFETS)	19.8	87,000	Volume reduce at 4 western, 3 eastern sites; disposal at 6 current disposal sites
Regionalized 5	4	6	0	23 (NO_2-ORR)	19.7	92,000	Volume reduce at 2 western, 2 eastern sites; disposal at 6 current disposal sites
Regionalized 6		2	0	16 (CO-LLNL)	13.0	174,000	Disposal at SRS and Hanford
Regionalized 7		2	0	67 (CO-NTS)	13.9	189,000	Disposal at SRS and NTS
Centralized 1		1	0	19 (NO_2-HS)	12.2	243,000	Centralized disposal at Hanford
Centralized 2		1	1	189 (CO-NTS)	11.1	257,000	Centralized disposal at NTS
Centralized 3	7	1	0	55 (NO_2-RFETS)	18.2	250,000	Volume reduce at 4 western, 3 eastern sites; disposal at Hanford
Centralized 4	7	1	1	128 (CO-NTS)	17.3	264,000	Volume reduce at 4 western, 3 eastern sites; disposal at NTS
Centralized 5	1	1	0	36 (PM_{10}-HS)	15.3	242,000	Volume reduce and dispose at Hanford

Notes: T = treat; "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. D = dispose. Each of the 6-site disposal alternatives uses the same sites; each of the 12-site disposal alternatives uses the same 12 sites.

[a] All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. For those alternatives where only minimum treatment occurs, the cells are left blank.

[b] Ten sites use existing facilities for volume reduction. Three sites (LBL, Mound, and RMI) not listed as major sites include volume reduction facilities.

Because of these sometimes contravening factors and the permanence associated with disposal decisions, it is prudent to further evaluate costs and discuss all pertinent aspects of potential configurations with stakeholders before identifying two or three preferred sites for disposal. The Department will notify the public which specific sites it prefers for disposal of LLW by publishing a notice in the *Federal Register* and by other means. DOE will not issue a Record of Decision selecting any regional disposal sites for LLW sooner than 30 days after publication of its preferred sites in the *Federal Register*.

Table 7.16–3 provides potential impacts for the preferred alternative by combining the impacts evaluated in the WM PEIS for the preferred alternative at each site. Although it is not possible to estimate disposal impacts with precision until the disposal sites have been selected, the table provides approximate values and ranges expected for the preferred LLW alternatives. Treatment and disposal impacts are taken from Volume II site data tables for the preferred alternatives specified in the second and third rows of Table 7.16–3. Values presented in the table for regionalized disposal use impacts estimated at Hanford, INEL, LANL, NTS, ORR, and SRS for Regionalized Alternative 3 (six disposal sites), Centralized Alternative 1 (one disposal site—Hanford), and Centralized Alternative 2 (one disposal site—NTS) to provide a range of potential impacts. Impact estimates under Centralized Alternative 1 at Hanford and Centralized Alternative 2 at NTS are greater than expected at either site. They provide an upper limit for the range of impacts at these sites, using impacts that result when all LLW is disposed of at one site—Hanford or NTS. The preferred disposal alternative would distribute disposal impacts over two to three sites, lowering values shown for Hanford or NTS.

Table 7.16-3. The Preferred LLW Alternative — Selected Impacts

Impact Area	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Total
Preferred alternative	T	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	
	D[a]	—	—	—	R	R	—	R	R	R	—	—	—	—	—	R	—	
Worker physical hazard fatalities	T	5.1E-02	4.3E-02	—	1.2E-01	1.5E-01	5.7E-02	1.4E-01	6.2E-03	2.8E-02	1.1E-01	2.5E-02	2.3E-01	8.0E-02	5.1E-02	4.4E-01	5.3E-02	1.6E+00
	D	—	—	—	0.0E+00-<1.4E+00	0.0E+00-2.5E-01	—	0.0E+00-4.1E-01	0.0E+00-<6.1E-01	0.0E+00-4.0E-01	—	—	—	—	—	0.0E+00-3.5E+00	—	6.1E-01-4.8E+00
	Total	5.1E-02	4.3E-02	—	1.2E-01-<1.5E+00	1.5E-01-4.0E-01	5.7E-02	1.4E-01-5.5E-01	6.2E-03-<6.2E-01	2.8E-02-4.3E-01	1.1E-01	2.5E-02	2.3E-01	8.0E-02	5.1E-02	4.4E-01-3.9E+00	5.3E-02	2.2E+00-6.4E+00
Worker cancer fatalities	T	3.2E-02	3.9E-02	—	9.9E-02	1.7E-01	2.5E-03	1.4E-01	3.0E-04	6.1E-02	1.5E-03	7.8E-04	4.6E-03	1.2E-03	4.1E-04	2.3E-01	1.3E-02	8.0E-01
	D	—	—	—	0.0E+00-<2.8E+00	0.0E+00-4.2E-01	—	0.0E+00-7.8E-01	0.0E+00-<2.2E+00	0.0E+00-5.5E-01	—	—	—	—	—	0.0E+00-5.8E-01	—	2.2E+00-2.8E+00
	Total	3.2E-02	3.9E-02	—	9.9E-02-<2.9E+00	1.7E-01-5.9E-01	2.5E-03	1.4E-01-9.2E-01	3.4E-04-<2.2E+00	6.1E-02-6.1E-01	1.5E-03	7.8E-04	4.6E-03	1.2E-03	4.2E-04	2.3E-01-8.1E-01	1.3E-02	3.0E+00-3.6E+00
Offsite population cancer fatalities	T	2.5E-06	2.3E-06	—	2.7E-06	8.0E-07	1.0E-02	2.1E-04	1.4E-12	5.0E-06	2.1E-08	4.4E-07	1.8E-09	4.0E-07	1.8E-06	1.9E-05	2.1E-06	1.0E-02
Radionuclides requiring constraints to meet ground-water standards	D	—	—	—	None or U-238	None	—	None	None	None	—	—	—	—	—	None or U-238	—	0-2 sites exceed

Table 7.16-3. The Preferred LLW Alternative — Selected Impacts—Continued

Impact Area	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	Total
Preferred alternative	T	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	R3	
	D[a]	—	—	—	R	R	—	R	R	R	—	—	—	—	—	R	—	
Truck radiation fatalities		These numbers reflect intersite transportation results and are not attributable to individual sites																2-16
Truck nonradiation fatalities																		3-38
Highest air pollutant percentage	T	12% NO_2	26% NO_2	—	0%	1% NO_2/PM_{10}	0%	1% NO_2/PM_{10}	5% CO	47% NO_2	7% NO_2	0%	0%	15% CO	0%	3% NO_2	0%	no sites exceed
	D	—	—	—	0% - 19% NO_2	—	—	—	0% - 183% CO	—	—	—	—	—	—	—	—	0-1 sites exceed
Cost $ billions	T	.11	.11	—	.24	.66	.21	.29	.04	.71	.28	.14	.17	.23	.11	.90	.33	4.53
	D	0	0	—	.0-3.8	0-.61	0	0-1.72	0-<2.95	0-2.16	0	0	0	0	0	0-4.04	0	3.0-9.3
	Total[b]	.11	.11	—	.24-<4.05	.66-1.27	.21	.29-2.0	.04-<3.0	.71-2.87	.28	.14	.17	.23	.11	.90-4.95	.35	7.5E-0-13.8E-0
Truck shipments		1,050	1,350	0	0-243,000	0-8,520	620	11,420-18,400	120-257,000	55,000-65,000	6,270	420	33,000	3,570	330	20-68,000	6,620	84,000-257,000[c]

[a] DOE prefers to further narrow its configuration of disposing sites to 2-3 sites from these 6 sites. DOE has no site preferences pending further deliberations with regulators and stakeholders.
[b] Total costs for the alternative as presented in Table 7.16-2 are calculated by adding additional treatment costs for non-major DOE sites (estimated at $1.4 billion) and truck transportation costs (which vary from $0.2 billion for R3 to $2.5 billion for C1) to the costs presented here. The total cost for the alternative could therefore vary between $11.4 billion and $15.4 billion. For the preferred disposal alternative, disposal volumes would range between zero and those quantities disposed of in the Regionalized Alternative 3, at INEL, LANL, ORR, and SRS. At Hanford volumes would range between zero and those evaluated for Centralized Alternative 1. At NTS volumes would range between zero and those evaluated for Centralized Alternative 2.
[c] Total one-way shipments between two sites, as defined for shipments in Table 7.16-2, range between values for Regionalized Alternative 3 and Centralized Alternative 2.

Chapter 7
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Low-Level Waste Alternatives

Alternatives	Number of Sites		ANL-E	BNL	FEMP	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP
	T	D																
No Action	10[a]	6				TD	TD	D	T	D	TD	T			T		TD	
Decentralized		16	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Regionalized 1		12			D	D	D	D	D	D	D	D	D	D	D		D	
Regionalized 2	11	12			TD	TD	TD	TD	TD	D	TD	TD	TD	TD	TD		TD	
Regionalized 3		6				D	D	D		D	D						D	
Regionalized 4	7	6				TD	TD	TD		D	TD			T	T		TD	
Regionalized 5	4	6				TD	TD	D		D	TD						TD	
Regionalized 6		2				D											D	
Regionalized 7		2								D							D	
Centralized 1		1				D												
Centralized 2		1								D								
Centralized 3	7	1				TD	T	T			T			T	T		T	
Centralized 4	7	1				T	T	T		D	T			T	T		T	
Centralized 5	1	1				TD												

Notes: T = treat. "Treat" in the context of LLW means volume reduction using thermal organic destruction, size reduction, and compaction followed by solidification. All sites perform "minimum treatment" in all alternatives, which consists of solidification of liquids and "fines" (powdered material), packaging, and shipment. D = dispose. Each of the 6-site disposal cases uses the same sites; each of the 12-site disposal cases uses the same 12 sites. Blanks indicate that no treatment or disposal takes place at these sites under the specified alternative.

[a] Ten sites use existing facilities for volume reduction. Three sites not listed as major sites above (LBL, RMI, and Mound) include volume reduction facilities.

CHAPTER 8
Impacts of the Management of Transuranic Waste

Chapter 8 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for transuranic waste (TRUW). This chapter provides information on existing and anticipated TRUW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to TRUW characteristics, the treatment and technologies considered, and the rationale for selecting the specific sites analyzed under each alternative. This chapter discusses the health risk, environmental impacts, and costs of the alternatives and provides a comparison of the alternatives.

The methods used to evaluate impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the TRUW analysis are contained in the technical report entitled "Transuranic Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports provided in Chapter 15.

8.1 Background

8.1.1 DEFINITION AND ORIGIN

Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for (a) high-level radioactive waste, (b) waste that the Secretary has determined, with the concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations, or (c) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by case basis in accordance with Part 61 of Title 10, Code of Federal Regulations (10 CFR 61) (WIPP Land Withdrawal Act, Public Law

- *TRUW is material produced during research and development, nuclear weapons production and dismantlement, and fuel reprocessing. It contains elements with atomic numbers greater than that of uranium, which has an atomic number of 92.*
- *TRUW is managed, or may be managed in the future, at 16 waste generator/storage sites, a number of other small generator sites, and a planned disposal site, the Waste Isolation Pilot Plant (WIPP).*
- *DOE's Waste Management Program will manage approximately 132,000 cubic meters of TRUW over the next 20 years.*
- *Although approximately 60% of TRUW contains both radioactive and hazardous components, DOE assumes that all TRUW is mixed waste for purposes of the WM PEIS analysis.*
- *DOE must select sites for the treatment and storage of TRUW.*

102-579).[1] The radioactive nuclides in transuranic waste emit alpha radiation, which requires minimal shielding when outside the body but can severely damage human tissue if taken into the body by inhalation, ingestion, or other means (such as through cuts). Transuranic waste requires long-term isolation from the environment. It is produced during reactor fuel assembly, research and development, nuclear weapons production, and spent nuclear fuel reprocessing. Transuranic waste contains traces of plutonium, with lesser amounts of neptunium, americium, curium, and californium. Other alpha-contaminated waste peculiar to a specific site may be managed as TRUW. For example, waste managed as TRUW at WVDP includes radioactive waste with concentrations of transuranic radionuclides as low as 10 nanocuries per gram, pursuant to the West Valley Demonstration Project Act.

Approximately 60% of TRUW is mixed waste, with both radioactive and hazardous components. However, for purposes of the WM PEIS analysis, DOE analyzes all TRUW as if it were mixed waste.

Because of its radioactive characteristics, TRUW falls under the jurisdiction of the Atomic Energy Act. In addition, TRUW's hazardous constituents are regulated under the Resource Conservation and Recovery Act (RCRA) (42 USC 6901 *et seq.*). The hazardous components, such as solvents and heavy metals, can be subject to RCRA land disposal restrictions (LDRs) (40 CFR 268) promulgated by the U.S. Environmental Protection Agency (EPA). The amendments to the Waste Isolation Pilot Plant Land Withdrawal Act contained in the 1997 Defense Authorization Act, however, exempt waste to be disposed of at WIPP from RCRA's provisions regarding LDRs.[2]

DOE plans to dispose of TRUW generated from defense activities and retrievably stored since 1970 at a geologic repository called the Waste Isolation Pilot Plant (WIPP), located near Carlsbad, New Mexico. In 1980, DOE issued a final environmental impact statement (EIS) on the proposed development of WIPP (DOE, 1980). DOE's record of decision (ROD), issued in 1981, called for the phased development of the repository. DOE prepared a Supplemental EIS (WIPP SEIS-I) in 1990 to analyze changes in environmental impacts since the 1980 EIS (DOE, 1990). In a 1990 ROD, DOE decided to continue with phased

[1]LLW and LLMW may also contain these transuranic isotopes, but with concentrations less than 100 nanocuries per gram of waste.

[2]The Waste Isolation Pilot Plant Land Withdrawal Act of 1992 provides for the disposal of 175,600 cubic meters (6.2 million cubic feet) of "defense TRUW" at WIPP provided all regulatory requirements are met. WVDP and other DOE sites have small amounts of "nondefense" TRUW. For purposes of analysis in this WM PEIS, DOE has assumed that all TRUW is defense TRUW and will be disposed of at WIPP. The impacts of treating and disposing of nondefense TRUW are evaluated in some of the alternatives analyzed in the second supplemental EIS for WIPP (WIPP SEIS-II) (DOE 1996e).

development of the WIPP. DOE is examining whether or not to dispose of TRUW in WIPP in a second supplemental EIS (WIPP SEIS-II) (DOE, 1996e).

However, disposal of TRUW cannot begin until DOE meets a series of regulatory requirements imposed under the Waste Isolation Pilot Plant Land Withdrawal Act, as well as other applicable regulatory and permitting requirements. Before shipment for disposal, all TRUW will be required to meet the Waste Isolation Pilot Plant Waste Acceptance Criteria (WIPP-WAC) that will be established by DOE in consultation with EPA and the State of New Mexico (DOE, 1991). However, this consultation process has not been completed yet, and additional treatment could be required to reduce the potential for gas generation at WIPP.[3] Since the Draft WM PEIS was prepared, DOE has revised the WIPP-WAC that it uses for planning purposes (DOE, 1996a). Revision 5 eliminated WAC that applied only to waste that would have been used in underground-test-phase experiments at WIPP, which were canceled, and revised the remaining requirements to make the document easier to use. Some additional requirements were added, including limits on volatile organic compounds and polychlorinated biphenyls. In general, the changes to the WIPP-WAC were minor, and the revised WIPP-WAC are slightly more restrictive than the previous version. Under the circumstances, the analysis in the Draft WM PEIS, which was based on Revision 4 of WIPP-WAC, is assumed to be adequate for the purposes of bounding the impacts that might be expected from packaging and treating waste to meet Revision 5 of WIPP-WAC.[4]

8.1.2 VOLUMES AND LOCATIONS

Table 8.1-1 presents the estimated total volume of TRUW from waste management activities at the 16 sites where the largest amounts of TRUW are currently present or projected. (Details on the amounts and characteristics of TRUW are provided in ANL [1996].) Of these 16 sites, 10 (ANL-E, Hanford, INEL, LANL, LLNL, NTS, ORR, PGDP, RFETS, and SRS) and the WIPP site, which currently does not contain TRUW, were fully evaluated for environmental impacts and costs for each alternative considered in the WM PEIS. For the remaining six (ETEC, LBL, Mound, SNL-NM, UofMO, and WVDP) and for Pantex, the

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3 Treatment to reduce gas generation is considered in this PEIS. For TRUW, gas could be generated by the corrosion of metals in the waste, the metal containers themselves, and by microbial decomposition of the waste. DOE is evaluating in the WIPP SEIS-II (DOE, 1996e) an alternative for disposal of TRUW after treatment to reduce gas generation. Recent studies suggest that gas generation will not affect WIPP's ability to contain hazardous and radioactive constituents of TRUW.

4 The WIPP SEIS-II (DOE, 1996e) evaluated Revision 5 of the WIPP-WAC.

Table 8.1-1. Transuranic Waste Volumes (cubic meters)

	Contact-Handled TRUW			Remote-Handled TRUW			
Site[a]	Inventory[b]	20-Year Projected Generation	Estimated Inventory + 20 Year Generation	Inventory[b]	20-Year Projected Generation	Estimated Inventory + 20 Year Generation	Total
ANL-E	15 (25)	940	960	0	340	340	1,300
ETEC	0.02 (2)	0	0.02	0 (6)	0	0	0.02
Hanford	12,000 (12,000)	24,000	36,000	200 (200)	15,400	16,000	52,000
INEL	38,000 (28,000)	280	38,000	110 (220)	500	610	39,000
LANL	8,200 (11,000)	2,500	11,000	79 (94)	10	89	11,000
LBL	0.8 (0)	0.2	1	0 (0)	0	0	1
LLNL	200 (230)	1,500	1,700	0 (0)	0	0	1,700
Mound	274 (300)	1,200	1,500	0 (0)	0	0	1,500
NTS	610 (620)	0	610	0 (0)	0	0	610
ORR	670 (1,300)	360	1,000	1,300 (2,500)	360	1,700	2,700
PGDP	14 (0)	0	14	0 (0)	0	0	14
RFETS[c]	1,500 (4,900)	4,800	6,200	0 (0)	0	0	6,200
SNL-NM	1 (7)	0	1	0 (0)	0	0	1
SRS	5,100 (2,900)	11,500	16,600	1 (0)	20	21	16,600
UofMO	0 (1)	2	2	0 (0)	0	0	2
WVDP	0.5 (0)	0	0.5	0 (0)	0	0	1
Total[d]	67,000 (61,000)	47,000	114,000	1,700 (3,000)	17,000	18,000	132,000
Other Sites Reporting TRUW Inventories:[e]							
Ames	(0)			(0)			
BCL	(0)			(580)			
Bettis	(0)			(0)			
Pantex	(1)			(0)			
TBE[f]	(1)			(0)			
USAMC[f]	(3)			(0)			

[a] WIPP, the seventeenth site, does not currently have any TRUW.
[b] Amount shown parenthetically indicates volume reported in BIR-2 (DOE, 1995c) and the WIPP SEIS-II (DOE, 1996e). Comparison of values is not necessarily appropriate because the BIR-2 estimates of volume reflect some level of treatment.
[c] Includes volume estimate of plutonium process residues.
[d] Volume data are rounded from field estimates and columns and rows do not add. Waste volume projections contained in this and other WM PEIS tables were based on 1993 or earlier data and may vary from the latest site estimates at the time of publication. Updated inventories and waste generation rates are summarized in Appendix I, "Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW."
[e] These sites are additional small quantity generators reported in the BIR-2 (DOE, 1995c) and the WIPP SEIS-II (DOE, 1996e) that constitute less than 1% of the total TRUW inventory.
[f] TBE = Teledyne Brown Engineering; USAMC = U.S. Army Material Command.

Sources: DOE (1992, 1993, 1995b,c).

TRUW volumes were very low (2 cubic meters or less) and did not warrant analysis of impacts because of the minimal amount of handling and packaging that would be required. However, the volumes for these six sites were included with waste that would be treated or stored at Regionalized or Centralized facilities. Waste volume managed at the 16 TRUW sites considered in the WM PEIS accounts for more than 99% of the Department's current and projected TRUW inventory.

TRUW is categorized as either contact-handled (CH) or remote-handled (RH) based on the level and type of radioactivity emitted. CH-TRUW consists primarily of alpha particles and low energy radionuclides with little penetrating power. CH waste containers can be handled directly by humans. As illustrated in Table 8.1–1, more than 85% of the total volume of TRUW is CH-TRUW. RH-TRUW typically contains a greater proportion of radionuclides that produce highly penetrating radiation (gamma radiation) and thus must receive special shielding in treatment, storage, and disposal facilities.

Since the initial preparation of the WM PEIS, DOE has issued updated information on TRUW volumes in the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report*, Revision 2 [WIPP BIR-2] (DOE, 1995c) and the *Mixed Waste Inventory Summary Report* [MWIR 95] (DOE, 1995b). Appendix I discusses how newly available data on TRUW may impact the analyses of alternatives in the WM PEIS. This more recent information revealed additional "small-quantity" generator or storage sites, which have or are expected to manage TRUW. The TRUW volumes at these small-quantity sites constitute less than 1% of the total TRUW inventory and are not expected to affect the TRUW analysis in the WM PEIS because sites with small amounts of TRUW are not well-suited for treatment facilities, as quantities of offsite TRUW greater than that stored onsite would have to be transported to such sites if they were proposed for treating TRUW in the various alternatives. Table 8.1–1 has been updated to identify these sites. Waste inventories from the BIR-2 for these sites, as well as for other sites, are expressed parenthetically because most of these data were not analyzed in the WM PEIS. The WIPP SEIS-II inventory is based on BIR-2.

Table 8.1–1 provides estimates of volumes of TRUW currently in inventory and estimates of the volumes DOE anticipates generating during the next 20 years; these estimates do not include wastes that may be generated as a result of environmental restoration activities.[5] The largest volumes of TRUW are located at

[5] The waste volumes also do not include TRUW generated before 1970. TRUW generated before 1970 is known as "buried TRUW." This waste is considered environmental restoration waste and will be managed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Section 8.15 of this chapter contains information regarding TRUW generated as a result of environmental restoration activities

10 sites, with 95% of the waste located at six of these sites: Hanford, INEL, LANL, ORR, RFETS, and SRS. Figure 8.1–1 presents the total TRUW volumes at the major sites. The data shown in Table 8.1–1 were obtained primarily from the *Interim Mixed Waste Inventory Report* (DOE, 1993) and *Integrated Data Base for 1992* (DOE, 1992),[6] with updated information on waste volumes used for two sites. As described in Appendix I, more recent data for TRUW were taken primarily from two sources: the *Mixed Waste Inventory Summary Report* [MWIR 95] (DOE, 1995b) and the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report, Revision 2* [WIPP BIR-2] (DOE, 1995c), with most of the new information taken from MWIR 95. MWIR 95 contains information on waste as it currently exists, and specifies treatability groups, and therefore is used in the WM PEIS analyses for calculating impacts from consolidating or decentralizing the treatment of TRUW throughout the DOE complex. Such information on as-generated waste forms is readily available from MWIR 95 but is not readily extracted from the WIPP BIR-2 data. A portion of the WIPP BIR-2 waste loads reflect some level of treatment because they are intended to represent the volume of wastes in the forms they might be disposed of at WIPP. The WIPP BIR-2 was also used for its radiological profiles and for more definitive waste volumes estimates for the years that are not covered by MWIR 95.[7]

DOE also reviewed a third version of the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report* [WIPP BIR-3] (DOE, 1996d), which was published in June 1996, and the *Integrated Data Base Report–1994* (DOE, 1995d), published September 1995. Although the radionuclide inventories at some sites are changed slightly, the waste volumes and hazardous constituent inventories in WIPP BIR-3 are unchanged from WIPP BIR-2. The WIPP BIR-3 and IDB Report–1994 databases were not available at the time of the WM PEIS analysis; however, the changes in WIPP BIR-3 and IDB Report–1994 are minor, and, therefore, WIPP BIR-2 data were considered to be sufficient for analytical purposes.

A comparison of MWIR 95 with more recent site information at Hanford (22,000 m^3 in WIPP BIR-2 as compared to 160 m^3 in MWIR 95) showed that it would be more appropriate to use data in the WIPP BIR-2

(including retrieval of buried TRUW) and the extent to which these waste volumes may affect the analyses in the WM PEIS.

6 These data were modified slightly because the TRUW reported at LLNL as remote-handled (RH) is actually contact-handled (CH) on the basis of information included in the 1994 Mixed Waste Inventory Report (DOE, 1994). For the rest of the sites, the waste volumes reported in the 1994 report do not vary significantly from the waste volumes reported in the 1993 interim report.

7 For impacts at potential treatment site, the Draft WIPP SEIS-II (DOE, 1996e) scaled or adjusted the analysis in the Draft WM PEIS to reflect BIR-2 and other updated information as explained in the Draft WIPP SEIS-II. (See Section 8.2.5.)

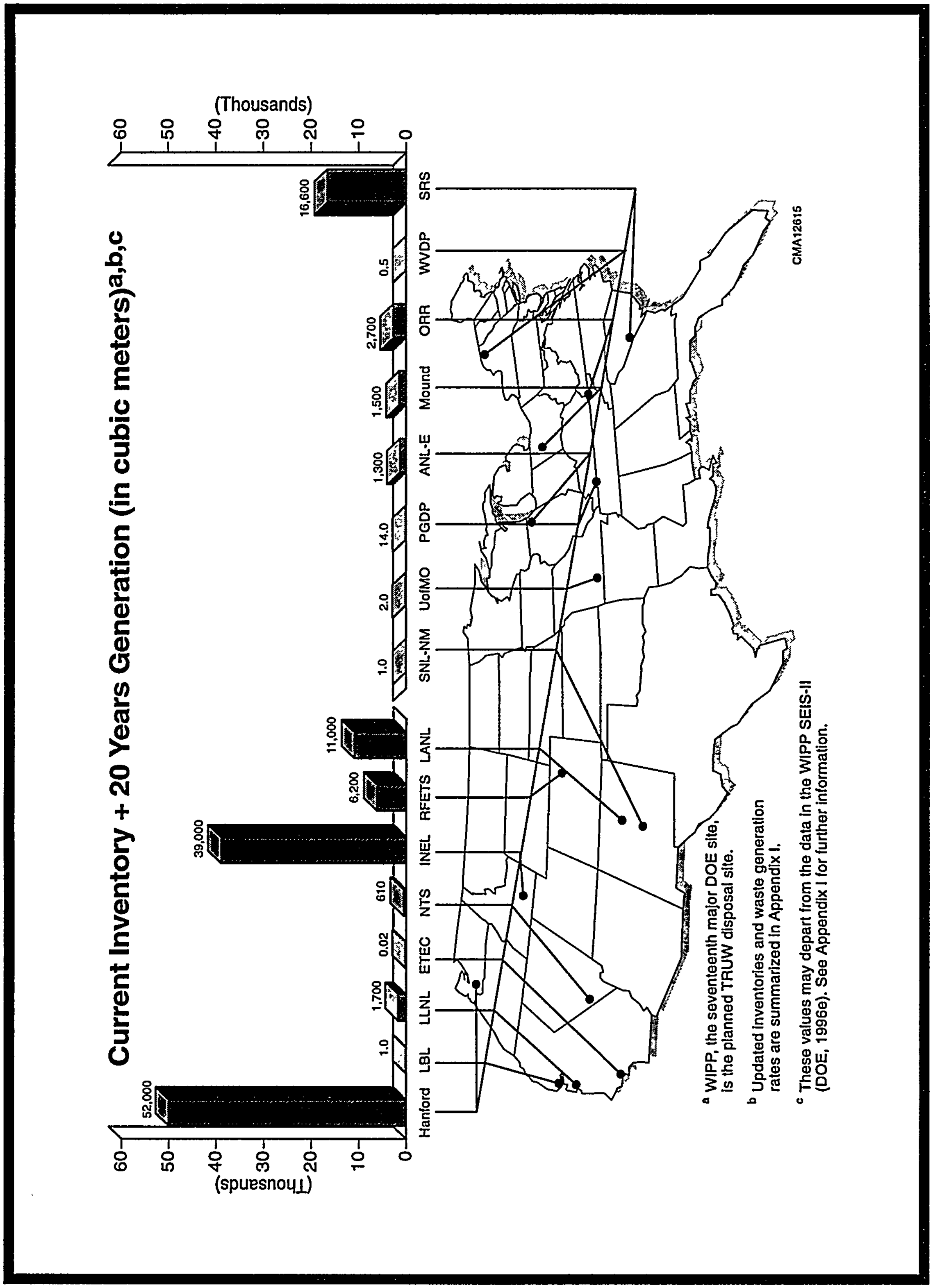


Figure 8.1–1. TRUW Total Inventory and Generation.

for Hanford, as the largest waste streams at Hanford would not be generated until after the 5-year period covered by MWIR 95 and thus do not appear in MWIR 95.

The analysis presented in the WM PEIS has been updated based on this newer information for Hanford and SRS in alternatives where these sites treat their own wastes. Additionally, WIPP waste loads have been updated in the Centralized Alternative. A more complete discussion of the criteria for selecting sites for reanalysis using the newer information is presented in Appendix I. This appendix also identifies the criteria for reanalyzing using the more recent data, compares the waste load data used in the Draft WM PEIS with the more recent data, and describes DOE's conclusions about the need to analyze the more recent data for specified sites.

8.1.3 Existing and Planned Facilities Available at DOE Sites

To establish the baseline capacities for TRUW treatment and to identify the need for new or expanded facilities, DOE compiled a list of existing and planned TRUW facilities. Total capacities of these identified facilities are presented in Table 8.1–2. Some facilities that are not currently operating were considered to be in existence for the analysis, based on the assumption that they could become operational if required. Planned facilities include only those facilities for which a Title II design has been initiated.

Analysis in the PEIS assumes use of existing and planned facilities until their capacities are met. If additional capacity is needed, use of new conceptual facilities is assumed. These conceptual facilities constitute the difference in treatment and storage capacity between the baseline reported in Table 8.1–2 and what is necessary to manage the waste that a given site would receive under an alternative. Conceptual facilities are based on generic designs with specified impacts (e.g., cost, performance, and efficiency). Where necessary for analysis, an assumption was made that the impact of existing facilities essentially reflects the impact of conceptual facilities.

Six sites have either existing or planned treatment facilities: Hanford, INEL, LANL, ORR, RFETS, and SRS (see Table 8.1–2). These facilities are each capable of performing different aspects of treatment including aqueous treatment, shredding, solidification, thermal treatment, and repackaging. DOE also assumed that the basic capabilities to package and store TRUW are available at every site that would

Table 8.1–2. Capacities of Existing and Planned TRUW Facilities

Site	Treatment (m^3/yr)					Storage (m^3)
	Aqueous Treatment	Shredding	Solidification	Thermal Treatment	Repackaging	
Hanford					1,400	
INEL					200	20,000
LANL	200		7.7	680[a]		
ORR			189			
RFETS	149,000	3,683	497		949	
SRS					200	15,300

Note: Blanks indicate that the treatment process or storage does not take place at the site.
[a] Thermal treatment unit at LANL is currently shut down and is being dismantled.

Source: DOE (1996b).

generate TRUW in the future. This includes 11 sites projected to generate CH TRUW and 5 sites with projected RH TRUW, as shown in Table 8.1–1.

8.2 Analytical Methods and Assumptions

To evaluate the TRUW alternatives, DOE first examined total waste volumes and the capability of existing or planned facilities. DOE then identified the chemical and radiological characteristics of TRUW in order to evaluate the effects of treatment. The specific assumptions used in the analysis related to TRUW facilities, treatment technologies, and transportation are discussed below.

8.2.1 Characteristics

8.2.1.1 Physical/Chemical

Although TRUW contains hundreds of waste streams, these streams can be grouped by physical and chemical properties into a limited number of waste treatment categories. In doing this, DOE was able to analyze a relatively broad range of TRUW by applying appropriate technologies dictated by the common physical and chemical treatment categories. Similar to low-level mixed waste (LLMW), the WM PEIS analysis of TRUW evaluated five treatment categories (or groupings): aqueous liquids, solid process residues, soils, organic liquids, and debris.

For the evaluation of impacts in the WM PEIS, DOE assumed that all TRUW is mixed waste. This assumption is conservative and consistent with practice in the field, where TRUW is managed as mixed waste unless definitive characterization has been performed to establish that there are no hazardous constituents present. The assumption that all TRUW contains hazardous constituents is conservative because it tends to overestimate the impacts of treating TRUW. DOE estimated the hazardous constituents in TRUW based on the TRUW present at RFETS, which has the most detailed process knowledge information on hazardous constituents available in the DOE system.

8.2.1.2 Radiological Profiles

Radionuclide concentrations for the 10 largest generators of TRUW were obtained from process knowledge, supplemented by limited sampling and analysis of stored TRUW. The radiological profiles at each site were derived from the estimated radionuclide concentrations in TRUW at the site. Insufficient data exist to assign unique radiological profiles to each individual waste stream at each site. Thus, a uniform radiological profile was assigned to all waste streams of a similar treatment category at each site (ANL, 1996). Updated information on radiological profiles was used in the Final WM PEIS for Hanford and SRS (DOE 1995b,c). Smaller generators were assumed to have the same concentrations as LLNL's TRUW (DOE, 1991). These radiological profiles identify the radionuclides likely to be encountered in TRUW and ultimately determine risk and impacts. DOE analyzed CH and RH TRUW separately in the WM PEIS to account for their different handling and treatment requirements.

8.2.2 Technologies and Treatment Processes

TRUW is treated by one or more treatment processes (or "modules"). Individual modules were linked together to form a complete treatment process for each treatability group. The emissions and impacts were calculated for each module and then added to determine the overall impacts from each treatment process at a site. Figures 8.2–1 through 8.2–3 represent simplified TRUW "treatment trains." These treatment trains are based on more detailed diagrams contained in the report, "Analysis of Waste Treatment

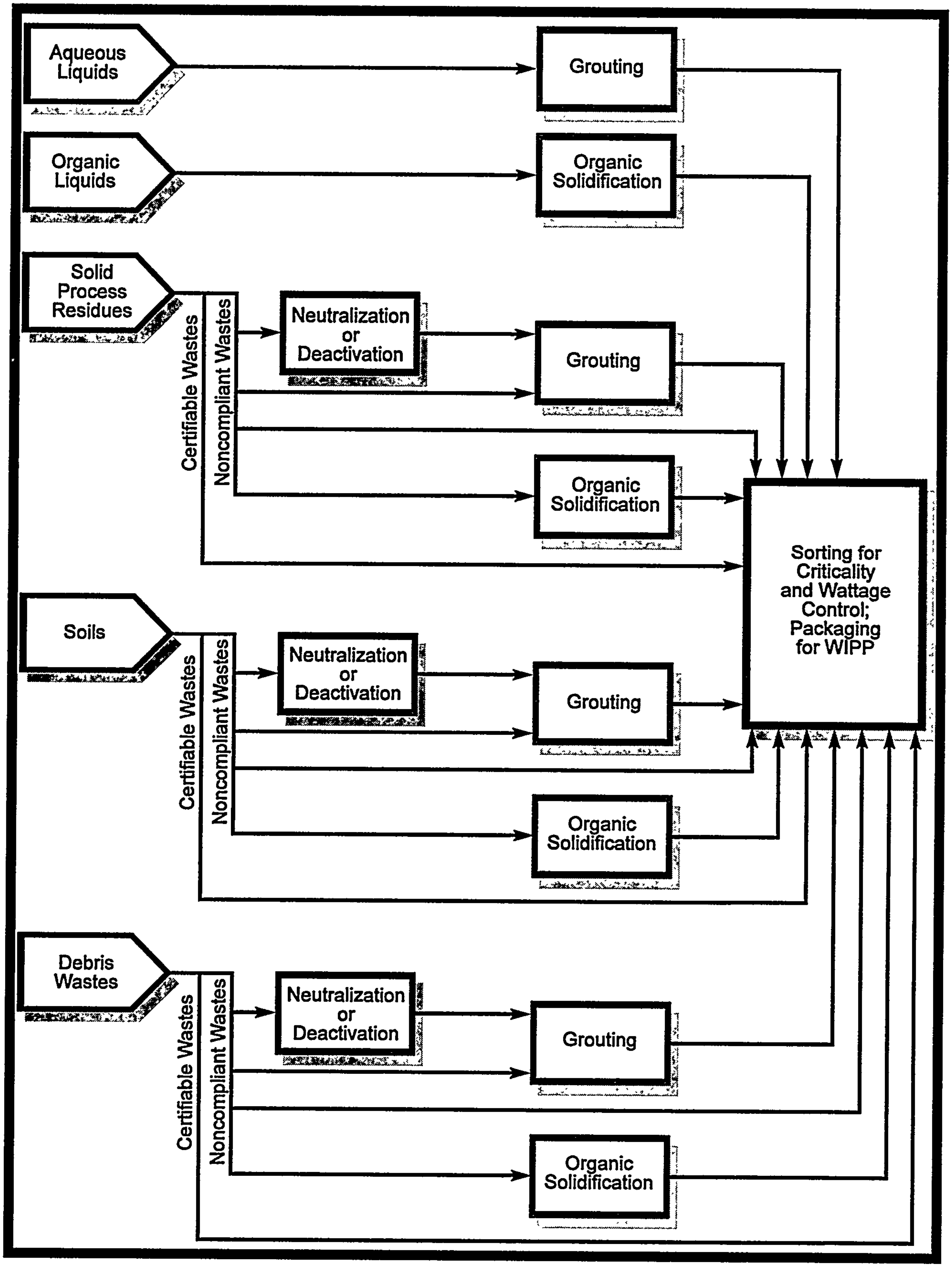


Figure 8.2-1. Treatment Trains for Meeting Current WIPP Waste Acceptance Criteria.

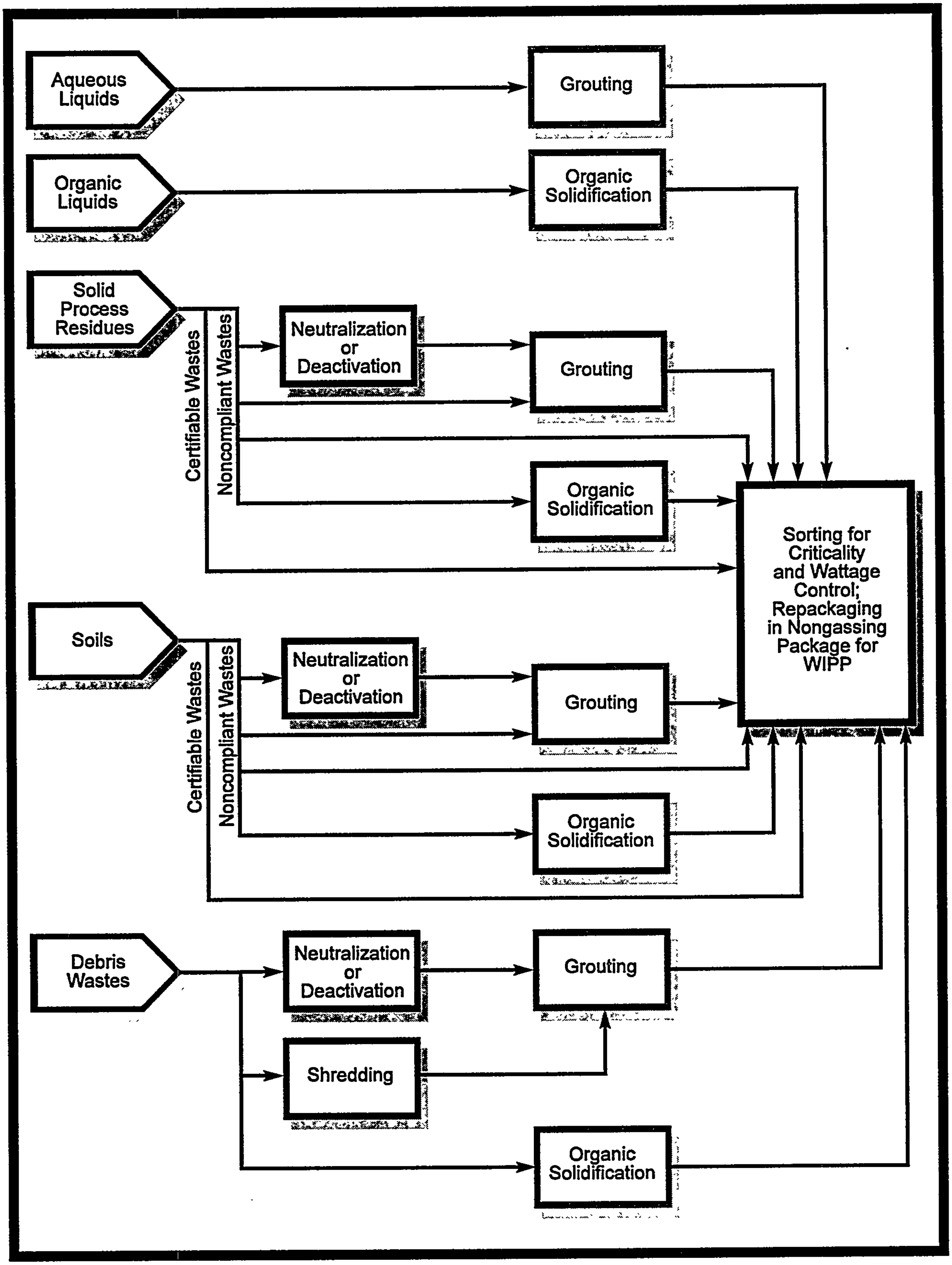


Figure 8.2–2. Treatment Trains for Reducing the Potential for Gas Generation in the WIPP.

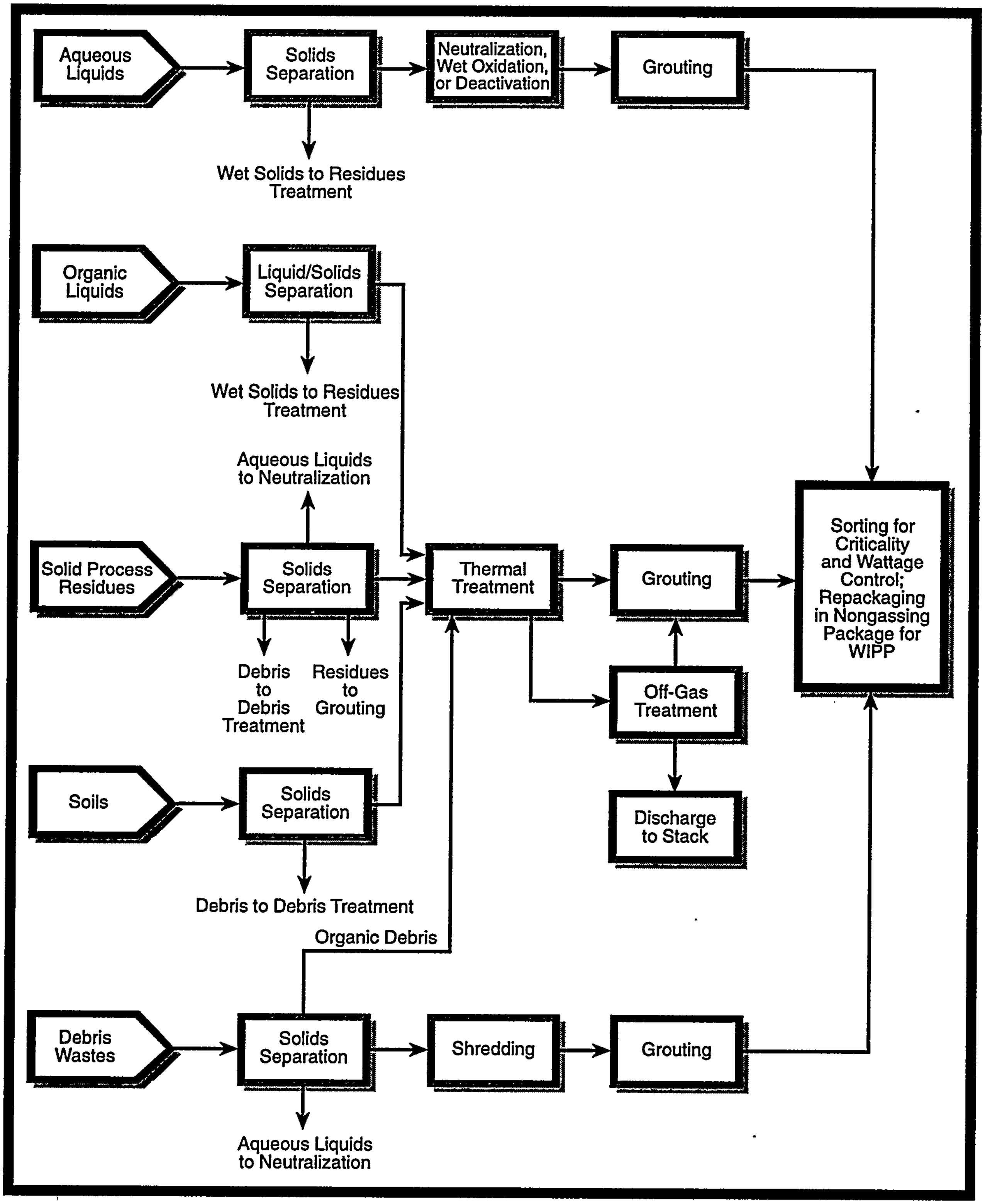


Figure 8.2–3. Treatment Trains for Meeting RCRA Land Disposal Restrictions.

Requirements for DOE Mixed Wastes: Technical Basis" (Musgrave, 1995). The waste volumes in Table 8.1-1 contain a small amount of TRUW (<1% of the total) that requires extensive characterization prior to treatment. Such TRUW is not evaluated in the WM PEIS since its characteristics are unknown and therefore impacts cannot be quantified. This small amount of TRUW would not affect comparisons among TRUW alternatives evaluated in the WM PEIS.

The conceptual process for managing TRUW is similar to that for LLMW and includes (1) retrieving from storage and transporting; (2) sorting, characterizing, treating as appropriate, packaging, and certifying as acceptable under WIPP-WAC; (3) storing certified waste; and (4) transporting to WIPP for disposal. To ensure that the full range of impacts were assessed, DOE considered minimal treatment to meet current WIPP-WAC, intermediate treatment to reduce gas generation potential, and a more extensive treatment process including thermal treatment to meet LDRs. The estimated risks, impacts, and costs of characterization are also included in the WM PEIS analysis. When selecting specific technologies for waste treatment facilities at specific sites, DOE will consider the results of existing sitewide or project-level NEPA analyses, as there are several different technologies that could be used to treat TRUW to the levels required for WIPP or other disposition alternatives.

DOE's current strategy is to process TRUW when it is necessary to meet safety and health requirements for transport and handling and to meet Revision 5 of the WIPP-WAC. Minimum processing to meet current (but not yet final) WIPP-WAC was the least stringent treatment analyzed. More extensive treatment to reduce gas generation or to meet LDRs was analyzed as an intermediate and an upper range of treatment should more extensive treatment become necessary.

8.2.3 WM PEIS Assumptions: Facilities, Treatment, and Storage

Although DOE used data on TRUW volumes and existing facilities from well-documented sources, the analysis of alternatives required DOE to make additional assumptions. In addition to estimating and extrapolating techniques used to identify the radiological and chemical characteristics of TRUW, DOE made additional general assumptions related to facilities, treatment, storage, and special requirements, to further define specific actions and operating parameters for each alternative.

Facilities

- Any new treatment facilities required for an alternative would be in operation after a 10-year design and construction period.
- TRUW currently in inventory (sometimes referred to as "legacy waste") plus 20 years of newly generated waste would be treated during the 10-year period after construction (called a "work-off" period). After the designated work-off period, TRUW is assumed to be treated as it is generated on an annual basis; although it was not analyzed, the amount of waste annually generated after the work-off period is expected to be small, and the impacts from treatment and storage are expected to be bounded by those analyzed in the WM PEIS.
- In the TRUW analysis, each site was assumed to build and operate facilities with capacities sufficient to handle only TRUW. This avoids linking the results of one waste type to decisions not yet made in another and results in conservative estimates of risk, impacts, and cost. Chapter 11 discusses the cumulative effects for sites hosting more than one waste-type facility.
- DOE assumed that either fixed or mobile characterization facilities would be operated at sites that would need to retrieve, treat, repackage, and ship TRUW. Characterization and repackaging of TRUW is often necessary to meet Department of Transportation (DOT) or RCRA regulations for transport, and to meet State shipping and receiving requirements.

Treatment and Storage

- Processing to meet current WIPP-WAC is practical at all sites with TRUW.
- More extensive treatment to reduce gas generation is practical at only the six sites with the largest volumes of TRUW because of the economies of scale associated with larger facilities. Treatment to meet LDRs is only practical at the same six sites or at a central location. In this analysis, WIPP was evaluated as the central treatment location.
- Impacts and costs were evaluated for retrieval of stored TRUW and for characterization and are included in the analysis results as a component of treatment.

8.2.4 Transportation Analysis and Assumptions

DOE analyzed transportation impacts associated with each TRUW alternative. In general, offsite transportation for treatment was minimized. Both truck and rail transportation were analyzed using computerized routing models following the general principle of minimizing distance and transportation time. The routes were selected to be consistent with existing practices and with all applicable regulations and guidelines; however, because the routes were developed for the purpose of risk assessment, they do not necessarily represent actual routes that would be used to transport waste in the future.

In general, the radiological risks from routine transportation of radioactive materials are directly proportional to the external dose rate, which is a measure of the external radiation (principally gamma radiation) from the shipment. The average external dose rates were assumed to be 3 millirem per hour for CH-TRUW and 7 millirem per hour for RH-TRUW at 1 meter from the shipping container. These values were derived from site-specific information contained in the WIPP SEIS-I (DOE, 1990) and are less than the DOT regulatory limit of 10 millirem per hour at 2 meters from the container.[8]

The following assumptions were used in the analysis:

- For purpose of analysis, this PEIS assumed that all CH-TRUW would be shipped in the TRUPACT-II Type B container.
- Waste package requirements for transportation of RH-TRUW would be based on the RH-72B cask described in a Safety Analysis Report for Packaging, which is being reviewed by the Nuclear Regulatory Commission (NRC) prior to issuance of a Certificate of Approval.

Transportation of hazardous and radioactive materials, substances, and wastes is governed by the U.S. Department of Transportation, NRC, and EPA regulations, and by the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

8.2.5 Comparison of Treatment Impacts with the WIPP SEIS-II

Both the WIPP SEIS-II (DOE, 1996e) and WM PEIS consider TRUW treatment. In addition to exploring TRUW disposal impacts, the WIPP SEIS-II will lead to a determination of minimum levels of TRUW treatment preparatory to final disposition; the WM PEIS will lead to a decision *where* to treat TRUW. Both the WM PEIS and the WIPP SEIS-II report the human health impacts from treatment of TRUW. The WIPP SEIS-II recognizes that treatment may be a major contributor to the overall impacts of disposing of TRUW and preparing TRUW for disposal, while the WM PEIS presents treatment impacts in order to assist decision makers in determining whether to centralize, regionalize, or decentralize actual treatment activities.

8 The WIPP SEIS-II (DOE, 1996e) assumes an average extreme dose rate of 4 millirem per hour for CH-TRUW, and 10 millirem per hour for RH-TRUW at 1 meter from the shipping container.

The approaches applied in the Final WM PEIS and the WIPP SEIS-II for estimating human health impacts from TRUW treatment are in general the same. The Draft WM PEIS analyses formed the basis of the WIPP SEIS-II analysis of treatment impacts. The impacts as a result of routine operations from the Draft WM PEIS were adjusted in the WIPP SEIS-II to account for the differences between the two documents in TRUW waste volumes and radionuclide inventories due to different periods of TRUW generation and site operation (28 years in the WIPP SEIS-II versus 20 years in the WM PEIS) and the addition of commercial and buried waste in the WIPP SEIS-II, number of sites producing waste, and the manner of waste consolidation as defined in the WIPP SEIS-II alternatives.

It should be noted that the Final WM PEIS provides updates and makes corrections to the analysis presented in the Draft WM PEIS. The preparers of the Final WIPP SEIS-II will review these WM PEIS changes to determine whether the Final WIPP SEIS-II should be similarly modified.

Comparison between the Final WM PEIS and the WIPP SEIS-II analyses of human health impacts from postulated accident scenarios is provided in Section 8.4.3.2.

8.3 Transuranic Waste Alternatives

The WM PEIS considered six alternatives for both CH-TRUW and RH-TRUW. Treatment and storage activities vary by alternative and by site. The foldout table at the end of this chapter shows the major sites at which TRUW would be treated and stored under each alternative. This table is designed to be used as a quick reference when reading the sections on TRUW impacts.

Each alternative was developed to evaluate the human health risk, environmental impacts, and costs associated with the range of treatment and storage activities available to DOE and to inform decisions about where to locate TRUW treatment and storage facilities.

The analysis includes alternatives in which TRUW would be treated to LDR levels. Although the WIPP LWA amendments contained in the 1997 Defense Authorization Act exempt waste destined for WIPP from the provisions in RCRA regarding LDRs, LDR treatment is a reasonable alternative for management activities and practices other than disposal at WIPP.

8.3.1 No Action Alternative

Under the No Action Alternative, DOE would continue to characterize, process, and package newly generated TRUW to meet current WIPP-WAC for storage at sites where existing or planned facilities are available. DOE would continue to store TRUW in existing storage facilities indefinitely. The impacts of these storage activities are analyzed for 20 years based on the scope of this PEIS. The impacts of storage beyond 20 years are analyzed as part of the No Action Alternatives in the WIPP SEIS-II (DOE, 1996e). As analyzed in the WIPP SEIS-II, if DOE continues to provide effective monitoring and maintenance of storage facilities, adverse health effects for the general public would be quite small, and the principal adverse effects, also small, would be related to occupational activity at the facilities. These health effects would continue at such levels for the indefinite future under the hypothesis of DOE control.

The analysis in the WIPP SEIS-II also considered, however, impacts if DOE were to lose institutional control of storage facilities. Considering the long-lived nature of the radionuclides in TRUW, this analysis was conducted for timeframes ranging up to 10,000 years after loss of institutional control. The WIPP SEIS-II analysis of intrusion for waste stored underground considered impacts of directly drilling into the wastes and gardening over the exhumed waste cuttings. Analysis of intrusion for waste stored above-ground considered impacts of an individual scavenging into the wastes and a farm family living over the wastes. The analyses showed that intruders could receive substantial radiation doses and that a potentially large number of non-intruders could die from exposure to stored waste that may be dispersed into the general environment.

Under the No Action Alternative, DOE would not ship TRUW for offsite, long-term storage or disposal. All sites are assumed to have adequate capabilities to package and store TRUW generated in the future. Eleven sites anticipate TRUW generation, including six sites that will generate both CH and RH TRUW. The potential impacts of TRUW management under the No Action Alternative are smaller than under the other alternatives because the No Action Alternative (1) evaluates treatment to WIPP-WAC only for future TRUW (existing retrievably stored TRUW would not be processed to meet current WIPP-WAC), (2) does not assess the impacts of removing TRUW from retrievable storage, and (3) does not include shipment of TRUW.

Figure 8.3–1 and Table 8.3–1 illustrate the sites at which TRUW would be processed and stored under the No Action Alternative.

TRUW No Action Alternative—(11 Sites Process to Current WIPP Criteria; Storage at Existing Facilities at 16 Sites)

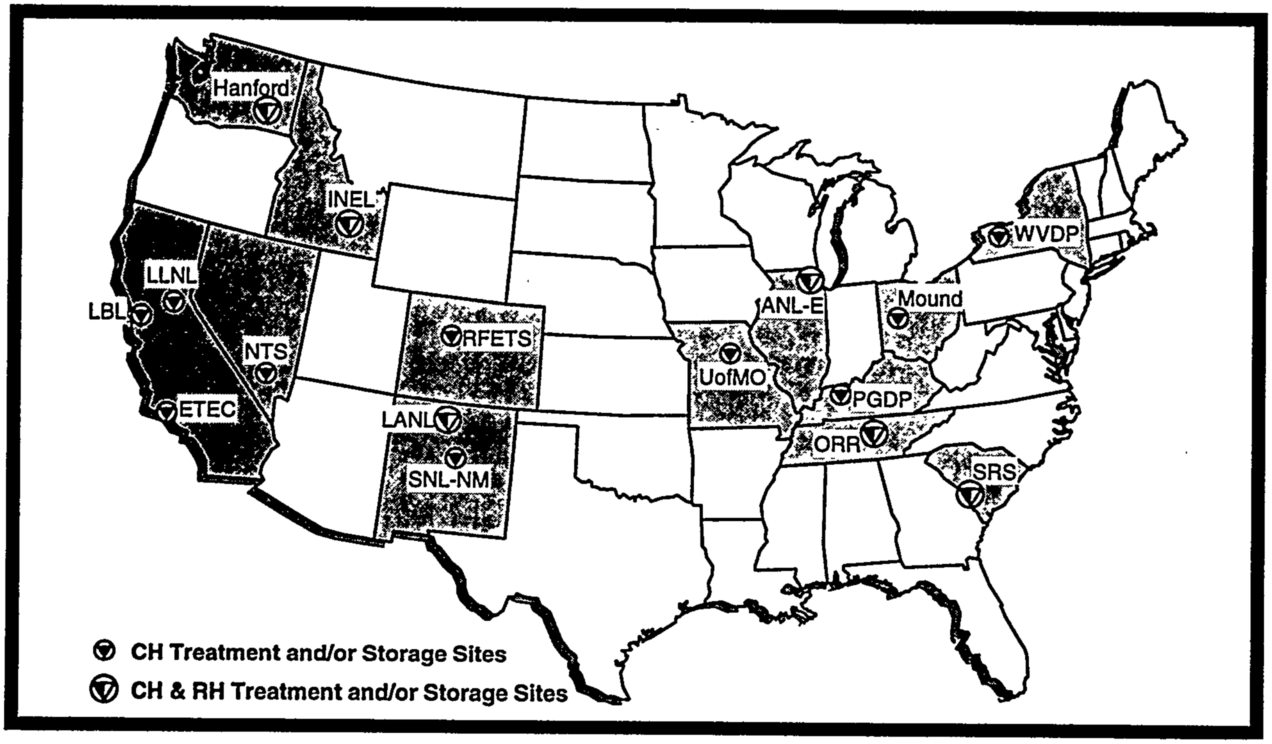


Figure 8.3–1. TRUW No Action Alternative.

	Generating Sites								
	ANL–E ANL–E^{RH}	ETEC	Hanford Hanford^{RH}	INEL INEL^{RH}	LANL LANL^{RH}	LBL	LLNL	Mound	NTS
Treat/Package (% Rec'd from Offsite)	ANL–E (0)		Hanford (0)	INEL (0)	LANL (0)	LBL (0)	LLNL (0)	Mound (0)	
Store	Store Onsite								

	Generating Sites						
	ORR ORR^{RH}	PGDP	RFETS	SNL-NM	SRS SRS^{RH}	UofMO	WVDP
Treat/Package (% Rec'd from Offsite)	ORR (0)		RFETS (0)		SRS (0)	UofMO (0)	
Store	Store Onsite						

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses; blank cells indicate sites store TRUW only.

Table 8.3–1. TRUW No Action Alternative

8.3.2 DECENTRALIZED ALTERNATIVE

Under the Decentralized Alternative, DOE would process and package TRUW to meet the current WIPP-WAC at 16 sites where TRUW is currently located. The CH-TRUW would then be shipped from sites with smaller amounts to the nearest of the 10 sites with the largest amount of TRUW for storage prior to disposal. All TRUW would be shipped to WIPP for disposal.[9] An important change from the No Action Alternative is that retrievably stored TRUW would be treated under this alternative, whereas it would not be treated under the No Action Alternative.

Figure 8.3–2 and Table 8.3–2 illustrate the sites at which TRUW would be processed and stored under the Decentralized Alternative.

8.3.3 REGIONALIZED ALTERNATIVES

The Regionalized Alternatives consider the consolidation of TRUW for treatment and storage prior to disposal at WIPP. Three Regionalized Alternatives were analyzed, with treatment (to reduce gas generation potential or to meet LDRs) at six and four sites, and storage at those sites prior to disposal at WIPP.

Under Regionalized Alternative 1, CH-TRUW would be shipped from the smallest generators to the four sites with the largest volumes of CH-TRUW (the Hanford Site, INEL, LANL, and SRS). In addition, RFETS would continue to treat its own waste, but would not receive waste from offsite. RH-TRUW would be shipped from ANL-E, INEL, and LANL to Hanford or ORR for treatment. At all six treatment sites, TRUW would be treated to reduce gas generation potential (referred to as intermediate treatment) and shipped from those sites to WIPP for disposal. The six treatment sites proposed under this alternative have 95% of current and anticipated TRUW inventories. Figure 8.3–3 shows the sites at which TRUW would be treated and stored under Regionalized Alternative 1. Table 8.3–3 lists the sites from which TRUW would be shipped and the six sites at which TRUW would be consolidated and treated.

[9] The Waste Isolation Pilot Plant Land Withdrawal Act of 1992 provides for the disposal of 175,600 cubic meters (6.2 million cubic feet) of "defense TRUW" at WIPP provided all regulatory requirements are met. WVDP and other DOE sites have small amounts of "nondefense" TRUW. For purposes of analysis in this WM PEIS, DOE has assumed that all TRUW is defense TRUW and will be disposed of at WIPP. The impacts of treating and disposing of nondefense TRUW are evaluated in some of the alternatives analyzed in the second supplemental EIS for WIPP (WIPP SEIS-II) (DOE 1996e).

TRUW Decentralized Alternative—(16 Sites Process to Current WIPP Criteria; Interim Storage at 10; Disposal at WIPP)

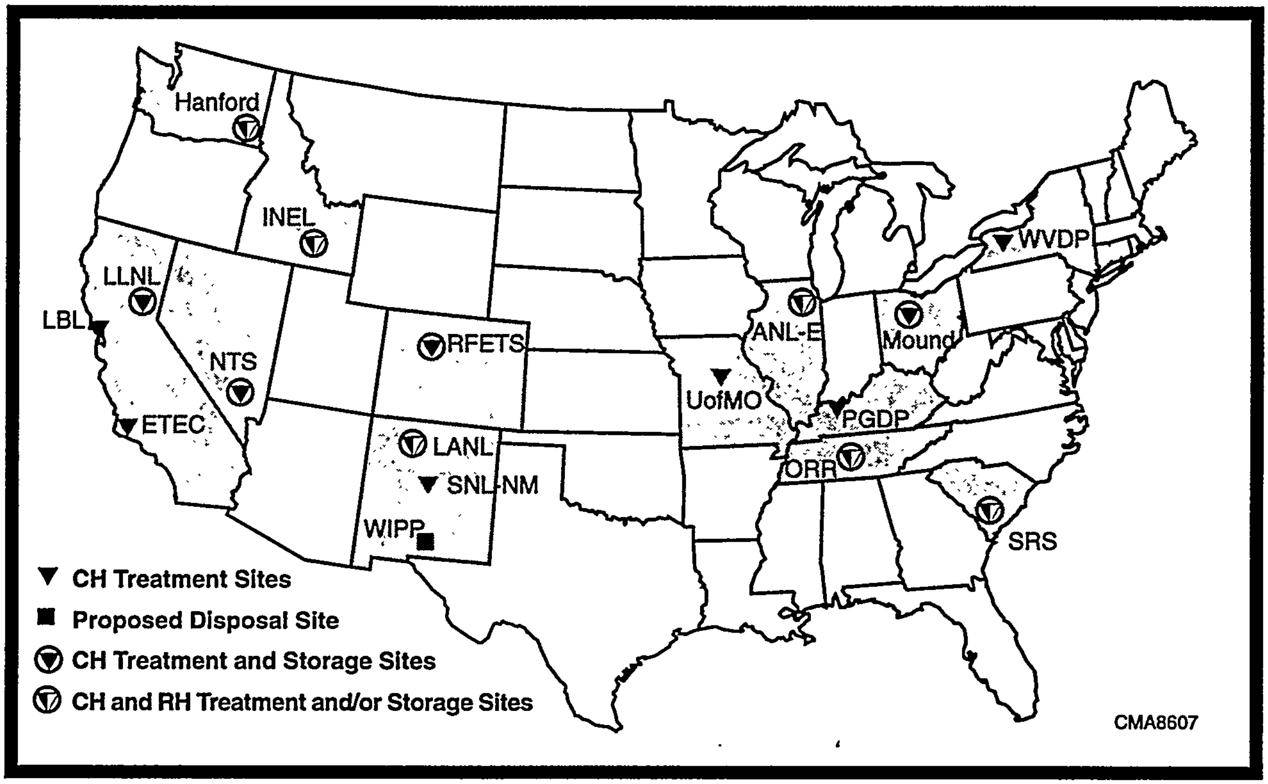


Figure 8.3-2. TRUW Decentralized Alternative.

	Generating Sites								
	ANL-E ANL-E^{RH}	ETEC	Hanford Hanford^{RH}	INEL INEL^{RH}	LANL LANL^{RH}	LBL	LLNL	Mound	NTS
Treat (% Rec'd from Offsite)	ANL-E (0)	ETEC (0)	Hanford (0)	INEL (0)	LANL (0)	LBL (0)	LLNL (0)	Mound (0)	NTS (0)
Store	ANL-E	NTS	Hanford	INEL	LANL	Hanford	LLNL	Mound	NTS
Dispose	All Sites Ship to WIPP								

	Generating Sites						
	ORR ORR^{RH}	PGDP	RFETS	SNL-NM	SRS SRS^{RH}	UofMO	WVDP
Treat (% Rec'd from Offsite)	ORR (0)	PGDP (0)	RFETS (0)	SNL-NM (0)	SRS (0)	UofMO (0)	WVDP (0)
Store	ORR	ORR	RFETS	LANL	SRS	ORR	Mound
Dispose	All Sites Ship to WIPP						

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3-2. TRUW Decentralized Alternative

Regionalized Alternative 1—(Treatment to Reduce Gas at 6 Sites; Disposal at WIPP)

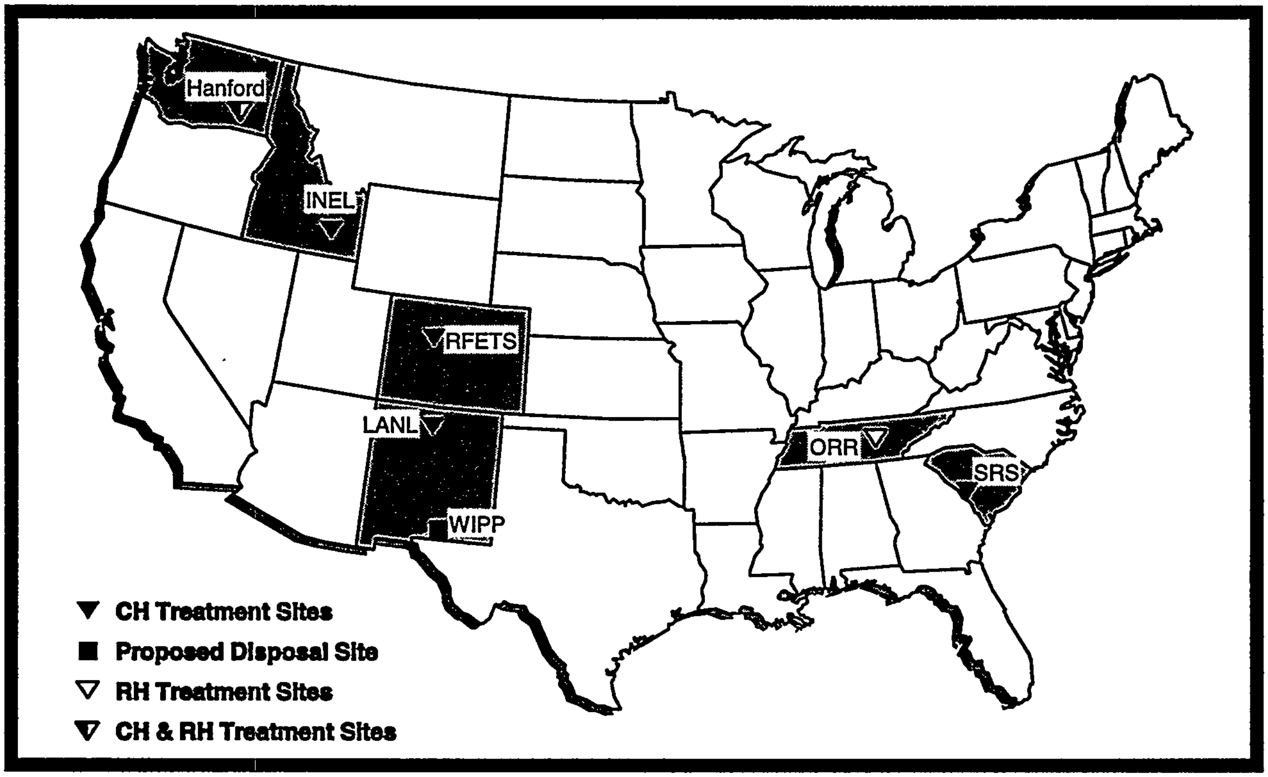


Figure 8.3-3. TRUW Regionalized Alternative 1.

	Generating Sites					
	Hanford, Hanford^{RH}, LBL, LLNL, INEL^{RH}, LANL^{RH}	ETEC, INEL, NTS	LANL, SNL-NM	SRS^{RH}, ANL-E^{RH}, ORR^{RH}	RFETS	ANL-E, Mound, ORR, PGDP, SRS, UofMO, WVDP
Treat (% Rec'd from Offsite)	Hanford (5)	INEL (1.5)	LANL (<1)	ORR (18)	RFETS (0)	SRS (17)
Dispose	All Sites Ship to WIPP					

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3-3. TRUW Regionalized Alternative 1

Under Regionalized Alternative 2, DOE would use the same configuration as in Regionalized Alternative 1, except that TRUW would be treated to meet LDRs and then shipped to WIPP for disposal. With this alternative, DOE can compare the impacts of intermediate treatment in Regionalized Alternative 1 to the impacts of LDR treatment in Regionalized Alternative 2; the impacts of both Regionalized Alternatives 1 and 2 can be compared to the impacts of meeting current WIPP-WAC in the Decentralized Alternative (where 98% of the waste would be processed at the same six sites). Figure 8.3–4 shows the sites at which TRUW would be processed and stored under Regionalized Alternative 2; Table 8.3–4 lists the sites from which TRUW would be shipped and the six sites at which TRUW would be consolidated and treated.

Regionalized Alternative 3 considers the consolidation of waste for treatment at four sites (Hanford, INEL, ORR, and SRS) where approximately 80% of TRUW is already located or is expected to be generated. CH-TRUW would be treated at Hanford, INEL, and SRS; RH-TRUW would be treated at Hanford and ORR. Under this alternative, TRUW would be treated to meet LDRs and shipped to WIPP for disposal. Figure 8.3–5 shows the four sites at which TRUW would be treated and stored under Regionalized Alternative 3; Table 8.3–5 lists the sites from which TRUW would be shipped and the four sites at which TRUW would be consolidated and treated.

8.3.4 Centralized Alternative

Under the Centralized Alternative, DOE would ship all CH-TRUW to WIPP for treatment to meet LDRs and for disposal. RH-TRUW would be shipped to the Hanford Site and ORR for treatment to meet LDRs and then shipped to WIPP for disposal. Figure 8.3–6 illustrates the Centralized Alternative. Table 8.3–6 shows the sites from which all TRUW would be shipped and the two sites at which RH-TRUW would be consolidated and treated.

8.3.5 Rationale for Selecting Treatment Sites

Treatment configurations for TRUW were developed to cover the range of reasonable alternatives. Thus, the Decentralized Alternative considers treatment of TRUW at 16 sites where TRUW is currently located, and the Centralized Alternative considers treatment of all CH-TRUW at one site and all RH-TRUW (which needs special handling) at two sites. For the regionalized alternatives, which are intermediate between the Decentralized and Centralized Alternatives, DOE focused on the six sites where 95% of the waste is located

Regionalized Alternative 2—(Treatment to LDRs at 6 Sites; Disposal at WIPP)

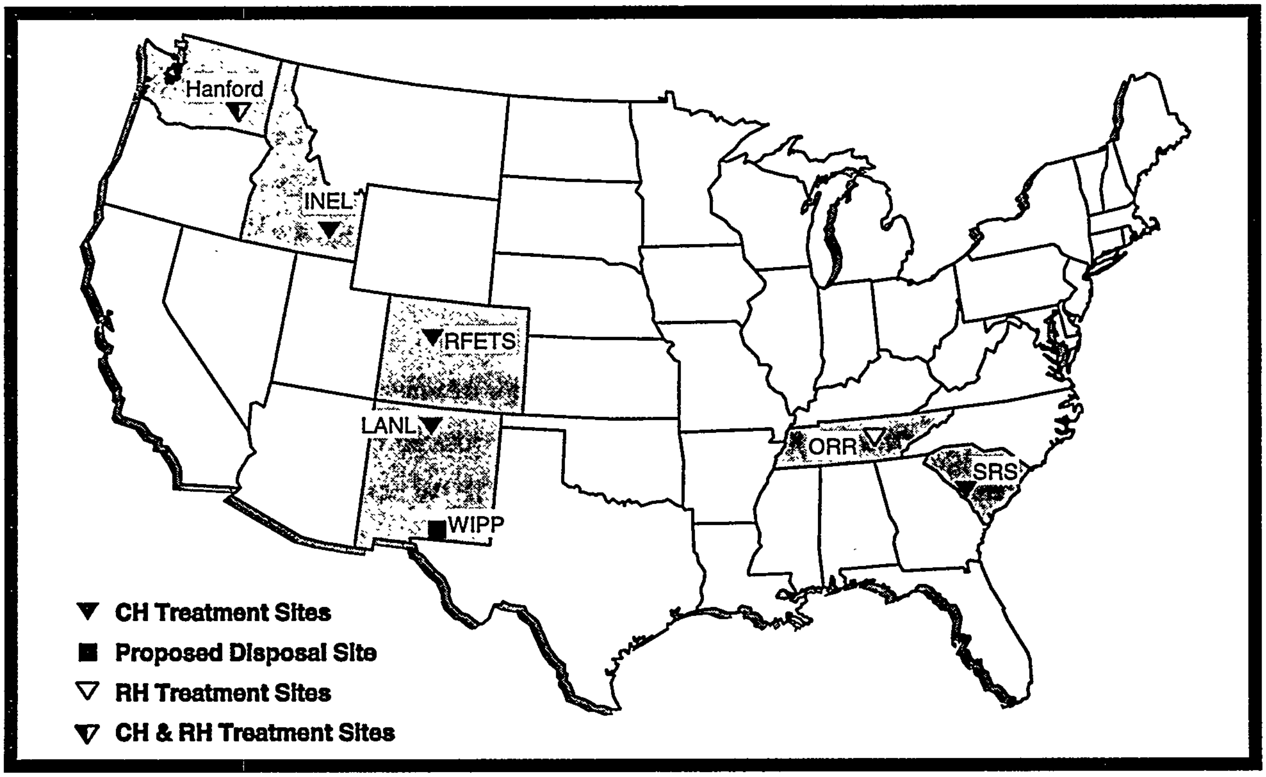


Figure 8.3–4. TRUW Regionalized Alternative 2.

	Generating Sites					
	Hanford Hanford RH INEL RH LANL RH LBL LLNL	ETEC INEL NTS	LANL SNL-NM	SRS RH ANL-E RH ORR RH	RFETS	ANL-E Mound ORR PGDP SRS UofMO WVDP
Treat (% Rec'd From Offsite)	Hanford (5)	INEL (1.5)	LANL (<1)	ORR (18)	RFETS (0)	SRS (17)
Dispose	All Sites Ship to WIPP					

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3–4. TRUW Regionalized Alternative 2

Regionalized Alternative 3—(4 Sites to Meet Treatment LDRs; Disposal at WIPP)

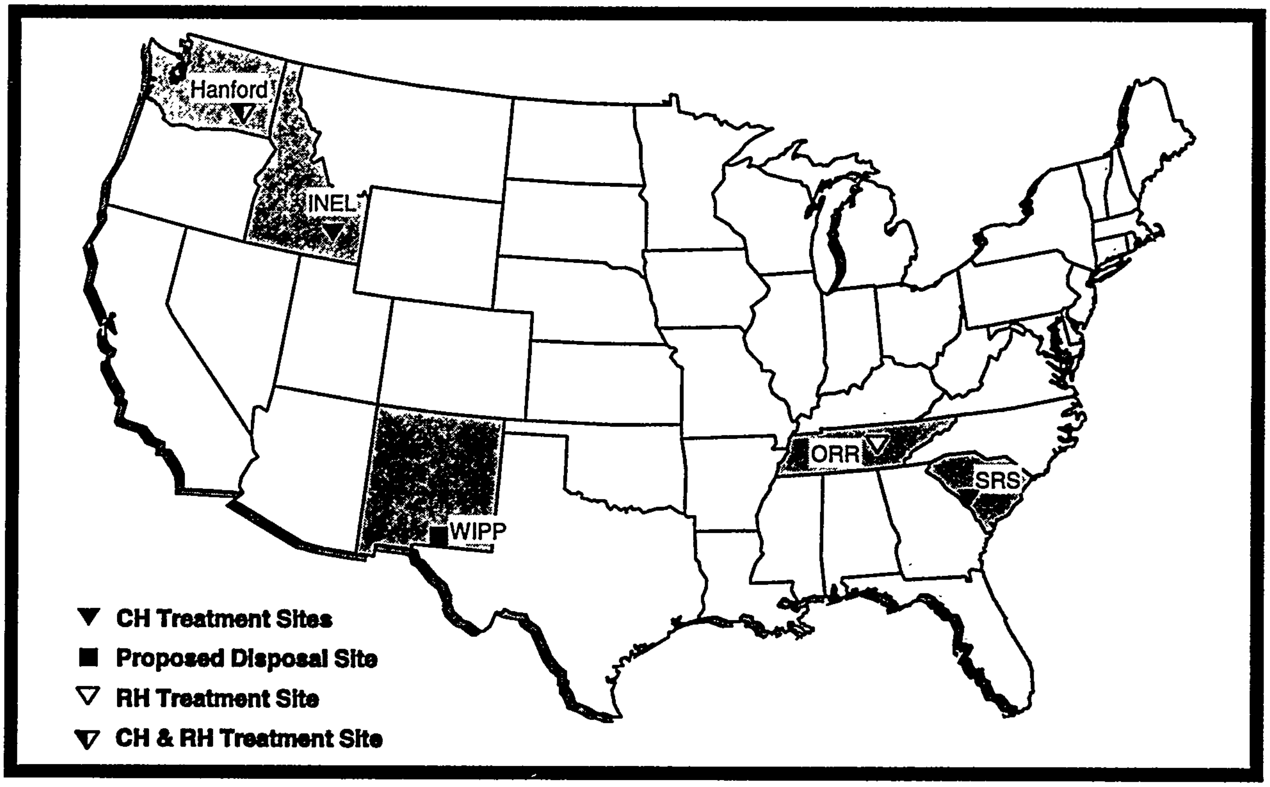


Figure 8.3–5. TRUW Regionalized Alternative 3.

	Generating Sites			
	Hanford Hanford^{RH} INEL^{RH} LANL^{RH} LBL LLNL	ETEC INEL LANL NTS RFETS SNL-NM	SRS^{RH} ANL-E^{RH} ORR^{RH}	ANL-E Mound ORR PGDP SRS UofMO WVDP
Treat (% Rec'd From Offsite)	Hanford (5)	INEL (31)	ORR (18)	SRS (17)
Dispose	All Sites Ship to WIPP			

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3–5. TRUW Regionalized Alternative 3

Centralized Alternative—(Treatment of CH at 1 Site and RH at 2 Sites to Meet LDRs; Disposal at WIPP)

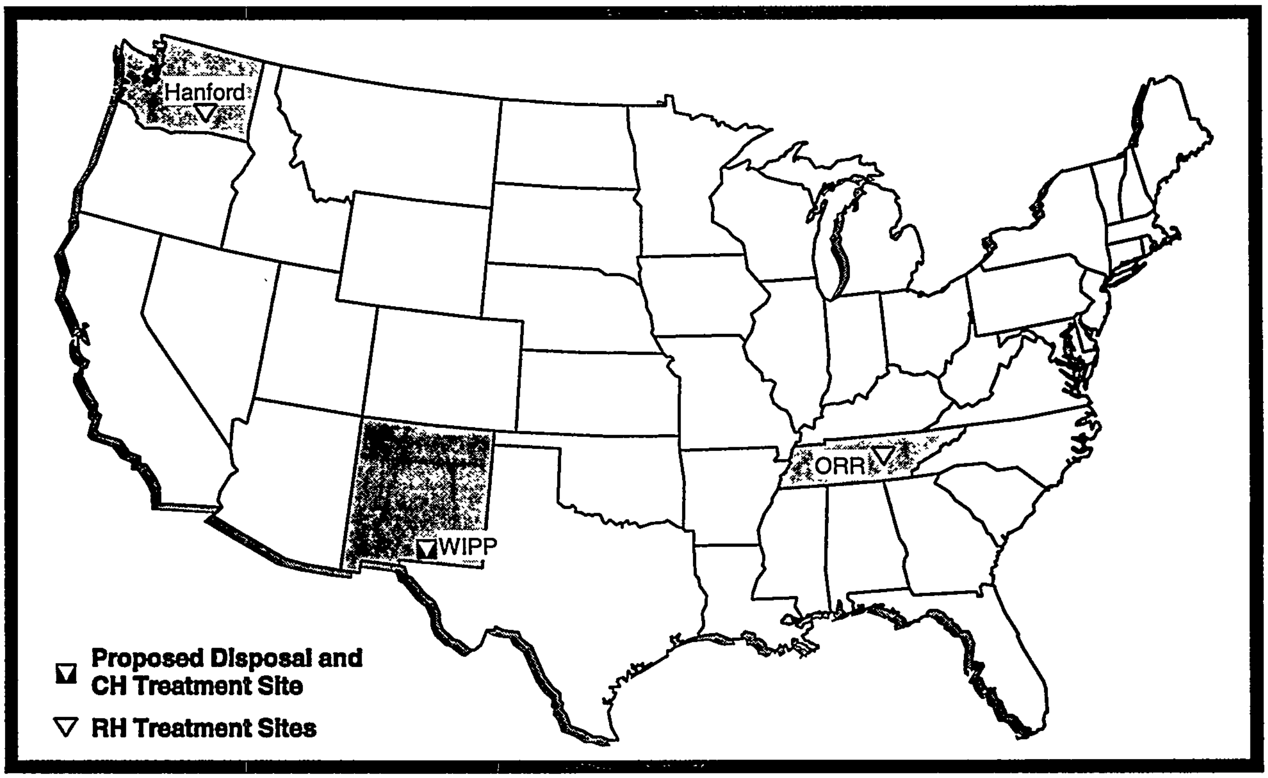


Figure 8.3-6. TRUW Centralized Alternative.

	Generating Sites			
	Hanford^{RH} INEL^{RH} LANL^{RH}	SRS^{RH} ANL-E^{RH} ORR^{RH}	ANL-E ETEC Hanford INEL LANL LBL LLNL Mound	NTS ORR PGDP RFETS SNL-NM SRS UofMO WVDP
Treat (% Rec'd From Offsite)	Hanford (5)	ORR (18)	WIPP (100)	
Dispose	All Sites Ship to WIPP			

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; percentage of waste a site would receive from offsite is indicated in parentheses.

Table 8.3-6. TRUW Centralized Alternative or expected to be generated, and on the four sites where approximately 80% of the waste is located or expected. Under these regionalized alternatives, DOE assumed that the waste from other sites with TRUW would be shipped to the closest site for treatment and storage.

In addition, DOE assumed that it would not be practical or reasonable for sites with small volumes of TRUW (less than 15 cubic meters) to treat TRUW onsite to either reduce gas generation potential or to meet LDRs. Thus, waste at the small-volume sites (e.g., ETEC, LBL, PGDP, SNL-NM, UofMo, and WVDP) was shipped to another site for treatment to either of these levels under the Regionalized and Centralized Alternatives. Onsite processing to meet current WIPP-WAC was considered for all 16 sites, including the small-volume sites, under the Decentralized Alternative.

Consolidation of RH-TRUW at one site for treatment was not considered because a large number of cross-country trips would be required, and because most RH-TRUW requires extensive treatment (not necessarily to meet LDRs) before it can be shipped. Thus, under the Centralized Alternative, DOE would treat RH-TRUW at the two sites—the Hanford Site and ORR—where approximately 90% of current and projected inventory would be located.

8.4 Health Risks

The most adverse health risks occur under alternatives where TRUW is treated to meet LDRs—in Regionalized Alternatives 2 and 3 and the Centralized Alternative. These alternatives require the thermal treatment of organic wastes, which results in emissions of radionuclides (Pu-238, Am-241) that have the greatest contribution to offsite cancer risks and increase the probability of cancer to the maximally exposed individual (MEI). Fatalities among workers result primarily from physical trauma and are lower when TRUW is processed to WIPP-WAC or treated to reduce gas generation potential rather than treated to meet LDRs. Estimated transportation fatalities are low in all alternatives.

Health risk impacts result from exposure to radiation and chemicals and from physical trauma during the construction and operation of TRUW treatment facilities and transportation of waste. Health effects resulting from radiation and chemical exposure, whether from sources external or internal to the body, can affect either the exposed individual's body (known as a "somatic" effect, i.e., cancer) or descendants of the exposed individual (known as a "genetic" effect). This section discusses the estimated adverse health impacts resulting from radiation and chemical exposures as well as the physical hazards for each TRUW treatment alternative. Details of the TRUW results are contained in Appendices D, E, and F. Methodology details are contained in Section 5.4.1 of Chapter 5 and in ORNL technical reports (ORNL, 1995a-d).

Potential health risks to a number of receptor populations and individuals are presented including:

- The offsite population—individuals living within a 50-mile radius of the site as well as along transportation routes.
- Noninvolved worker population—workers at DOE sites who are not involved directly in waste management.
- Waste management worker population (or "waste management workers")—employees working at a site's waste management facilities, including workers who manage waste, construction workers who build the waste management facilities, and workers who operate the trucks and trains that transport the waste.
- MEIs for the offsite population—hypothetical individuals in the offsite population who are assumed to receive the highest total lifetime dose from all media.
- MEIs for the noninvolved worker population— hypothetical individuals in the noninvolved worker population who are assumed to receive the highest total lifetime dose from all media.

The following sections present the impacts for the TRUW Alternatives:

8.4 Health Risks
8.5 Air Quality Impacts
8.6 Water Resources Impacts
8.7 Ecological Resources Impacts
8.8 Economic Impacts
8.9 Population Impacts
8.10 Environmental Justice Concerns
8.11 Land Use Impacts
8.12 Infrastructure Impacts
8.13 Cultural Resources Impacts
8.14 Costs
8.15 Environmental Restoration Analysis
8.16 Comparison of Alternatives Summary

The impacts evaluated were:

- Fatalities from physical hazards (e.g., vehicle accidents)
- Cancer fatalities from radiation exposure
- Cancer incidences from radiation or chemical exposure
- Genetic effects from radiation exposure
- Noncancer effects from chemical exposure (e.g., headaches, nasal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and developmental toxicity)

Maximally Exposed Individual

In keeping with standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual" (MEI). The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week, for the 10-year period of treatment operations analyzed in the PEIS.

Interpreting the results of health risk analyses involves consideration of both uncertainties and appropriate standards. See Section 5.4.1 and Appendix D for a further discussion of these issues.

8.4.1 Routine Operation Impacts

For operations involving TRUW treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in TRUW treatment ("noninvolved workers"), and waste management workers directly involved in TRUW treatment. Impacts were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative were implemented. Table 8.4-1 provides the estimated number of individuals in the offsite populations at the proposed TRUW treatment and storage sites and the number of waste management workers for each alternative. The numbers of waste management workers are derived from generic baselines that established the number of personnel required to operate treatment facilities needed to manage a given amount of waste (INEL, 1995b).

Individual impacts focus on the *probability* that the MEI within each receptor population would experience an adverse health impact. Because the focus is on the MEI, the risk is presented as a probability (e.g., one-in-one million, or 1E–06) of that individual experiencing an adverse health impact, rather than a total number of impacts for a selected population.

DOE analyzed effects of both radionuclides and chemicals on individuals and populations. The pathways of exposure analyzed were inhalation, ingestion of plants and animals, direct gamma radiation, and absorption of tritium through the skin.

Worker risks associated with physical hazards were evaluated for 20 years: a 10-year period of construction of treatment facilities, and a subsequent 10-year period of operation. However, worker and public risks from radionuclide or chemical exposure (received during the 10-year operation period) were evaluated for an entire lifetime (70 years), because health impacts from airborne contaminants or direct radiation could occur throughout the lifetime of the exposed individual.

Table 8.4–1. Offsite Populations and Waste Management Treatment Worker Populations

Site	Offsite Population*	WM Treatment Worker Population by Alternative[a]					
		No Action	Decentralized	Regionalized 1	Regionalized 2	Regionalized 3	Centralized
ANL-E	7,939,785	136	337	150	150	150	150
Hanford	377,645	899	1,519	2,312	3,621	3,621	1,993
INEL	153,061	132	2,471	3,205	5,469	6,382	1,691
LANL	159,152	262	1,115	1,537	2,807	748	748
LLNL	6,324,234	148	354	186	186	186	186
NTS	14,266	0[b]	204	137	137	137	137
ORR	881,652	41	272	314	682	682	682
PGDP	500,502	0[b]	15	8	8	8	8
RFETS	2,171,877	353	664	989	1,852	420	420
SRS	620,618	324	556	948	1,412	1,412	368
WIPP	99,889	--	--	--	--	--	4,132

Notes: -- = no waste treatment occurs at the site under this alternative; * = within 50 mile radius of sites. Waste management worker population estimates represent full-time equivalents (FTEs) over the entire construction and operation periods.
[a] Because ETEC, LBL, Mound, and UofMo are not "major" waste management sites analyzed in the WM PEIS (see Section 1.6) and because it was assumed that it would not be practical or reasonable to treat the small volume of TRUW at SNL-NM or WVDP, values are not provided for these sites.
[b] Sites reporting zero workers are sites where no TRUW was generated as reported in the 1992 Integrated Data Base (DOE, 1992). There would be no treatment of newly generated TRUW under the No Action Alternative.

Table 8.4–2 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for TRUW treatment.

This human health risk analysis includes evaluation of both the potential numbers of fatal cancers as well as the numbers of total cancer incidences induced by exposure to radionuclides and direct radiation. The numbers of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases. Note that both the *total cancer incidence* and the *nonfatal cancer incidence* values are overestimated by a factor of about two because the estimates contain a relatively large component of skin cancers. The internal exposure pathways evaluated in the WM PEIS (e.g., inhalation or ingestion of radionuclides) are not likely to induce large numbers of skin cancer cases. However, the International Commission on Radiological Protection (ICRP) dose conversion factors used in the WM PEIS to estimate total cancer incidence includes incidences of skin cancer (ICRP, 1990).

Table 8.4–2. TRUW Health Risk Analysis Components

TRUW Treatment					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of trauma fatalities	WM workers	Physical hazards	Physical hazards	20 years	8.4–3
Number of cancer fatalities	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4–3
	Noninvolved workers		Inhalation, direct radiation		
	WM workers		Inhalation, direct radiation		
Number of cancer incidences	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4–4
		Chemicals	Inhalation, ingestion		
	Noninvolved workers	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
	WM workers	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
Number of genetic effects	Offsite population	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4–4
	Noninvolved workers		Inhalation, direct radiation		
	WM workers		Inhalation, direct radiation		
Probability of cancer fatality	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4–5 8.4-6
	Noninvolved worker MEI		Inhalation, direct radiation		
Probability of cancer incidence	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4–7
		Chemicals	Inhalation, ingestion		
	Noninvolved worker MEI	Radionuclides	Inhalation, direct radiation		
		Chemicals	Inhalation		
Probability of genetic effects	Offsite MEI	Radionuclides	Inhalation, ingestion, direct radiation	10 years	8.4–7
	Noninvolved worker MEI		Inhalation, direct radiation		

__Understanding Scientific Notation__

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

__Positive Powers of 10__
$10^1 = 10 \times 1 = 10$
$10^2 = 10 \times 10 = 100$
and so on; therefore,
$10^6 = 1{,}000{,}000$ *(or 1 million)*
etc.

__Negative Powers of 10__
$10^{-1} = 1/10 = 0.1$
$10^{-2} = 1/100 = 0.01$
and so on; therefore,
$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^5 can also be written as 3E+05, and 3×10^{-5} is equivalent to 3E-05. Therefore, 3E+05 = 300,000 and 3E-05 = 0.00003.

The health risk data tables in this section use "E" notation with negative exponents.

Probability is expressed as a number between 0 and 1. The notation 3E-06 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated results (e.g., fatal cancer) will occur in the period covered by the analysis.

8.4.1.1 Estimated Number of Fatalities

Table 8.4–3 presents an overview, by alternative, of the total estimated programwide fatalities associated with TRUW treatment. This table presents the estimated number of fatalities to the offsite population, noninvolved workers, and waste management workers caused by radiological exposure. In addition, the table shows the estimated number of waste management worker deaths resulting from physical hazards during facility construction and operation.

For each alternative except No Action, there is at least one estimated fatality associated with treatment operations. Most of these fatalities occur within the waste management worker population, and result from physical hazards involved in construction and operation of TRUW treatment facilities. Only waste management workers are exposed to these physical hazards, and therefore, have more estimated fatalities than other receptor groups. Overall the estimated number of waste management worker fatalities due to

Table 8.4-3. TRUW Treatment: Estimated Number of Fatalities Programwide[c]

	Number of Sites			WM Worker		Offsite Population Radiation Exposure	Noninvolved Worker Radiation Exposure
Alternative	**CH Treat**	**RH Treat**	**Treatment Standard**	**Physical Hazards**	**Radiation Exposure**		
No Action[a]	11	5	WIPP-WAC	*	*	*	*
Decentralized[b]	16	5	WIPP-WAC	2	1	*	*
Regionalized 1	5	2	Reduce gas	3	1	*	*
Regionalized 2	5	2	LDRs	4	1	1	*
Regionalized 3	3	2	LDRs	3	1	*	*
Centralized	WIPP	2	LDRs	2	1	*	*

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; * = greater than 0 but less than 0.5.
[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.

physical hazards exceeds the number of estimated fatalities to the offsite and the noninvolved worker populations for all alternatives. In general, risk to waste management workers appears to decrease when TRUW is treated to less stringent standards. That is, estimated fatalities are less when TRUW is processed to meet current waste acceptance criteria or to reduce gas generation potential than when it is treated to meet LDRs. A single latent cancer fatality is estimated for the waste management worker population under each alternative except No Action. It should, however, be noted that potential radiological impacts provided in the WM PEIS are based on analyses that include prudently conservative release, exposure, and risk factor estimates. DOE would use ALARA ("As Low As Reasonably Achievable") procedures and monitoring to reduce the actual doses received by the workforce.

Regionalized Alternative 2 also produces an estimated single latent cancer fatality in the offsite population at LANL from the thermal treatment of waste that contains americium-241. DOE may mitigate this potential effect by reducing emissions by means of special oxidation or other treatment or offgas control techniques that would be examined in sitewide or project-specific NEPA reviews. Site-specific estimated latent cancer fatalities for TRUW can be found in the site data tables in Volume II.

8.4.1.2 Estimated Number of Cancer Incidences and Genetic Effects

Table 8.4–4 presents an overview, by alternative, of the total programwide incidences of cancer and genetic effects associated with treatment of TRUW. These impacts result from exposures of the offsite, noninvolved worker, and waste management worker populations to chemicals and radiation. In addition, dose estimates are included for the offsite, noninvolved worker, and waste management worker populations.

Each of the alternatives has estimates of one or more cancer incidences resulting from radiation exposure. The greatest numbers of estimated cancer incidences resulting from treatment of TRUW to meet LDRs occur in the offsite populations at LANL and Hanford under Regionalized Alternative 2 and Hanford under Regionalized Alternative 3. This result reflects thermal treatment of waste that contains americium-241 at LANL and plutonium-238 at Hanford, which, as previously mentioned, would require special mitigation measures. There is a reduction in offsite population cancer incidences from treatment to meet LDRs under the Regionalized 3 and Centralized Alternatives. Estimated cancer incidences and genetic effects for TRUW can be found in the site data tables in Volume II.

LANL, Hanford, and WIPP are the only sites that have an estimated incidence of at least one cancer in the offsite population as a result of radiation exposure. Treatment to meet LDRs is forecast to cause this at Hanford and WIPP predominantly because of plutonium-238, whereas americium-241 accounts for most of the risk at LANL. Mitigation of the emissions from thermal treatment of these radionuclides may be accomplished through application of alternative treatment concepts when these become available, or by enhancing off-gas treatment systems, if these alternatives are selected. Specific mitigation measures would be evaluated in sitewide or project-specific NEPA reviews. Cancer incidences resulting from chemical exposure and genetic effects resulting from radionuclide and radiation exposure were not estimated to exceed one for any receptor group under any alternative.

8.4.1.3 Probability of MEI Cancer Fatalities

Table 8.4–5 summarizes, by alternative, the highest estimated *probability* at any site of latent fatal cancer from radiation exposure. This table presents the risk of cancer fatality to the MEI within the offsite and noninvolved worker populations. The numbers in this table are the estimated *probabilities* that the MEI will die of cancer from radiation exposure.

Table 8.4–4. TRUW Treatment: Estimated Number of Cancer Incidences and Genetic Effects Programwide[c]

Alternative	Number of Sites		Treatment Standard	Offsite Population				Noninvolved Workers				WM Workers			
	CH Treat	RH Treat		Radiation Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Radiation Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action [a]	11	5	WIPP-WAC	0.08	*	*	*	0.007	*	*	*	400	1	*	*
Decentralized [b]	16	5	WIPP-WAC	0.3	*	*	*	0.03	*	*	*	1,510	2	*	*
Regionalized 1	5	2	Reduce gas	0.5	*	*	*	0.05	*	*	*	1,620	2	*	*
Regionalized 2	5	2	LDRs	1,990	3	*	*	3	*	*	*	1,640	2	*	*
Regionalized 3	3	2	LDRs	469	1	*	*	40	*	*	*	1,740	3	*	*
Centralized	WIPP	2	LDRs	609	1	*	*	4	*	*	*	2,040	3	*	*

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; * = values greater than 0 but less than 0.5.

[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.

[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.

Table 8.4–5. TRUW Treatment: Greatest Probability of Cancer Fatality at Any TRUW Site[c]

Alternative	Number of Sites		Treatment Standard	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
	CH Treat	RH Treat			
No Action [a]	11	5	WIPP-WAC	4E–10	2E–09
Decentralized [b]	16	5	WIPP-WAC	6E–09	7E–09
Regionalized 1	5	2	Reduce gas	7E–09	1E–08
Regionalized 2	5	2	LDRs	7E–05	5E–05
Regionalized 3	3	2	LDRs	5E–06	2E–05
Centralized	WIPP	2	LDRs	7E–05	9E–05

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.

The probability of a cancer fatality to the MEI was calculated for each site, and the highest values under each alternative are presented in Table 8.4–5. The MEI risk is not a combined total of risks across all of the sites in an alternative. This table indicates that the TRUW alternatives with treatment to meet LDRs have the highest cancer fatality probabilities for the MEI of the offsite and noninvolved worker populations. The other alternatives, which process TRUW to WIPP-WAC or treat it to reduce the potential of gas generation, have probabilities of cancer fatalities that are less by three orders of magnitude or more.

Table 8.4–6 presents the probability of a fatal cancer from radiological exposure for the offsite MEIs for all sites by treatment alternative. The data in Table 8.4–6 are graphically presented in Figure 8.4–1. Essentially, all sites that conduct treatment to meet LDRs have relatively higher cancer fatality probabilities than those that do not treat to meet LDRs. Air emissions of plutonium-238 are responsible for the relatively higher risk estimates at Hanford and WIPP, whereas americium-241 accounts for most of the risk at INEL, LANL, and RFETS.

Estimates of the potential release of alpha radionuclides to the air based on more recent waste loads at INEL and RFETS result in increases in the offsite MEI cancer fatality probabilities, and produce risk estimates in excess of one in one million for these sites for the Regionalized Alternative 2. Other risks (e.g., noninvolved worker MEI cancer fatality probability, offsite MEI cancer incidence probability) posed by the release of alpha radionuclides could increase as well (see Appendix I).

Table 8.4-6. TRUW Treatment: Offsite MEI Cancer Fatality Probabilities[c]

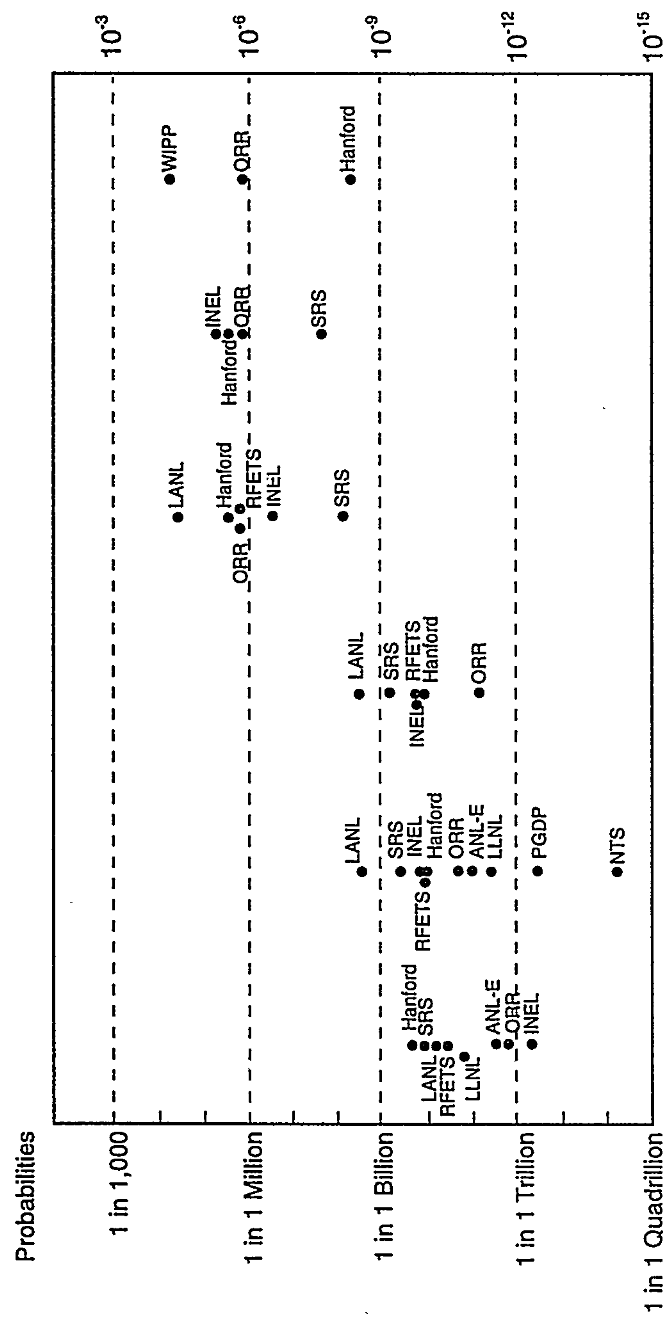
Alternative	Number of Sites: CH Treat	Number of Sites: RH Treat	Treatment Standard	ANL-E	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	RFETS	SRS	WIPP
No Action [a]	11	5	WIPP-WAC	3E-12	2E-10	8E-13	4E-10	2E-11	--	2E-12	--	4E-11	2E-10	--
Decentralized [b]	16	5	WIPP-WAC	1E-11	5E-10	1E-10	6E-09	6E-11	3E-14	2E-11	4E-13	1E-10	7E-10	--
Regionalized 1	5	2	Reduce gas	1E-11	9E-10	2E-10	7E-09	6E-11	4E-14	3E-11	6E-13	2E-10	1E-09	--
Regionalized 2	5	2	LDRs	1E-11	3E-06	9E-07	7E-05	6E-11	4E-14	1E-06	6E-13	1E-06	2E-08	--
Regionalized 3	3	2	LDRs	1E-11	3E-06	5E-06	7E-09	6E-11	4E-14	1E-06	6E-13	2E-10	2E-08	--
Centralized	WIPP	2	LDRs	1E-11	1E-08	2E-10	7E-09	6E-11	4E-14	1E-06	6E-13	2E-10	3E-10	7E-05

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant Waste Acceptance Criteria. Analysis was not conducted for Offsite MEI Cancer Fatality Probabilities at SNL-NM and WVDP due to low TRUW inventory. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.

[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.



	NA	D	R1	R2	R3	C
CH Treat At	11 Sites	16 Sites	5 Sites	5 Sites	3 Sites	WIPP
RH Treat At	6 Sites	6 Sites	2 Sites	2 Sites	2 Sites	2 Sites
Treat STD	WIPP-WAC	WIPP-WAC	Reduce Gas	LDRs	LDRs	LDRs

note: chart in logarithmic scale

CH = Contact-Handled TRUW LDRs = Land Disposal Restrictions

RH = Remote-Handled TRUW WIPP-WAC = Waste Isolation Pilot Plant Waste Acceptance Criteria

Figure 8.4–1. Probability of Cancer Fatality to Offsite MEI—TRUW.

8.4.1.4 Probability of MEI Cancer Incidence and Genetic Effects

Table 8.4–7 summarizes, by alternative, the highest estimated *probability* at any site of cancer incidence and genetic effects resulting from chemical and radiation exposure. This table presents these estimated risks for the MEI within the offsite and noninvolved worker populations.

Each of the TRUW alternatives involving treatment to meet LDRs has estimated probabilities of cancer incidence and genetic effects relatively greater than alternatives that do not involve treatment to meet LDRs. This includes the MEI in both the offsite and noninvolved worker populations.

All seven sites that would conduct treatment to meet LDRs (the Hanford Site, INEL, LANL, ORR, RFETS, SRS, WIPP) have relatively higher estimated probabilities of cancer or genetic effects than sites that would not treat to LDRs. Probabilities of cancer from chemical exposure were lower than probabilities of cancer from exposure to radiation. Estimated cancer incidences and genetic effects for TRUW can be found in Volume II in the site data tables.

8.4.1.5 MEI Noncancer Risks

The "Hazard Index" is the EPA's standard indicator of potential noncancer toxicity caused by exposure to hazardous chemicals. It is derived by comparing estimated exposure to concentrations of noncarcinogenic chemicals to concentrations presumed to be protective of human health over an entire lifetime, assuming continuous low-level exposure. If the Hazard Index exceeds one, the estimated exposure concentrations exceed the concentrations presumed to be without adverse health effects. In the WM PEIS, the Hazard Index was estimated for the offsite population MEI and noninvolved worker MEI.

For waste management workers, an "Exposure Index" rather than a Hazard Index was estimated. The Exposure Index is derived by comparing the estimated exposure concentrations to appropriate occupational exposure limits. The Exposure Index was considered to be a better measure for waste management workers because the Hazard Index uses standards designed to protect the health of the general population, including sensitive subgroups, such as children. Workers are generally assumed to be healthier than the general population, and worker populations contain fewer sensitive subgroups. Therefore, the concentrations of noncarcinogenic chemicals presumed to be protective of human health are different for these two groups

Table 8.4–7. TRUW Treatment: Estimated Greatest Probability of Cancer Incidence and Genetic Effects at Any Site[c]

Alternative	Number of Sites		Treatment Standard	Offsite MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Radiation Dose (rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Radiation Dose (rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action [a]	11	5	WIPP-WAC	0.000001	2E–09	7E–13	1E–10	0.000005	8E–09	3E–10	5E–10
Decentralized [b]	16	5	WIPP-WAC	0.00001	2E–08	1E–11	1E–09	0.00002	6E–08	6E–11	2E–09
Regionalized 1	5	2	Reduce gas	0.00001	2E–08	1E–11	1E–09	0.00003	5E–08	7E–11	3E–09
Regionalized 2	5	2	LDRs	0.1	2E–04	1E–11	1E–05	0.03	2E–04	5E–11	9E–06
Regionalized 3	3	2	LDRs	0.01	2E–05	1E–11	1E–06	0.03	5E–05	5E–11	3E–06
Centralized	WIPP	2	LDRs	0.1	2E–04	6E–12	1E–05	0.2	3E–04	4E–11	2E–05

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria;
* = greater than 0 but less than 0.0005 rem. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
[c] These values may differ from the WIPP SEIS-II (DOE, 1996e); refer to Section 8.2.5 for discussion.

of receptors. If the Exposure Index exceeds one, the estimated concentrations exceed the concentrations presumed to be without adverse health effects.

None of the Hazard or Exposure Indices estimated for the alternatives evaluated exceeded one; therefore, no noncancer risks are expected as a result of TRUW treatment.

8.4.2 Transportation-Related Impacts

Transporting TRUW for treatment and storage may affect the health of the truck drivers, rail crew, and the public along the transportation route. These impacts are the result of physical injury from vehicle accidents, radiation-induced latent cancers from normal operations, accidents where the waste containers are assumed to open, chemical exposure during accidents, and exposure to vehicle exhaust. For all alternatives except No Action, shipments were assumed to occur uniformly over a 10-year period, assuming a 10-year period to build treatment and storage facilities. There would be no transportation in the No Action Alternative.

The methods used to estimate transportation risks as well as relevant information concerning the types of shipping casks assumed are described in Appendix E. Tables 8.4–8 and 8.4–9 present the total number of estimated fatalities associated with truck and rail transportation of TRUW, respectively. Table 8.4–8 shows that if DOE shipped TRUW by truck, there is one additional fatality estimated for truck drivers under the Decentralized Alternative than under the other alternatives. Otherwise, the estimated number of latent cancer and traffic accident fatalities are approximately the same for all alternatives. Risks from rail transport are estimated to be slightly less than risks estimated for truck transport (Table 8.4–9).

The health impacts associated with exposure to the hazardous chemical components of TRUW that might be released during accidents are presented in Appendix E. No incidences of cancer or noncancer health effects associated with transportation were estimated for any alternative.

Table 8.4-8. Estimated Fatalities for TRUW Truck Transportation From Vehicular Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Treatment Standard	Estimated Number of Radiological Fatalities[a]		Estimated Number of Nonradiological Fatalities	
	CH Treat	RH Treat		Normal Operations Public	Normal Operations Crew	Fuel Emissions	Injury From Traffic Accidents
No Action [b]	11	5	WIPP-WAC	0	0	0	0
Decentralized [c]	16	5	WIPP-WAC	2	2	*	3
Regionalized 1	5	2	Reduce gas	2	1	*	3
Regionalized 2	5	2	LDRs	2	1	*	2
Regionalized 3	3	2	LDRs	2	1	*	3
Centralized	WIPP	2	LDRs	2	1	*	3

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria.
* Greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced cancer.
[b] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; for all other alternatives, disposal at WIPP is assumed.
[c] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table 8.4-9. Estimated Fatalities for TRUW Rail Transportation From Rail Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Sites		Treatment Standard	Estimated Number of Radiological Fatalities[a]		Estimated Number of Nonradiological Fatalities	
	CH Treat	RH Treat		Normal Operations Public	Normal Operations Crew	Fuel Emissions	Injury From Traffic Accidents
No Action [b]	11	5	WIPP-WAC	0	0	0	0
Decentralized [c]	16	5	WIPP-WAC	1	*	*	*
Regionalized 1	5	2	Reduce gas	*	*	*	*
Regionalized 2	5	2	LDRs	*	*	*	*
Regionalized 3	3	2	LDRs	*	*	*	*
Centralized	WIPP	2	LDRs	1	*	*	*

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; LDRs = Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria.
* Greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced latent cancer.
[b] For No Action Alternative, storage is indefinite, no disposal at WIPP is assumed; for all other alternatives, disposal at WIPP is assumed.
[c] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

8.4.3 Facility Accident Impacts

8.4.3.1 Storage Facility Accidents

Accidents and source terms for current storage were not analyzed explicitly. Unlike treatment, which will chiefly use new facilities that have common characteristics, current (pretreatment) storage uses a variety of preexisting facilities that vary greatly with regard to the amounts and types of waste inventories they store, the arrangements in which the inventories are stored, and the containment characteristics of the storage enclosures. However, recent DOE safety analysis reports (SARs) and NEPA reviews provide guidance on the potential impacts of accidents in existing LLMW and TRUW storage facilities.

These current SARs and EISs are valid indicators of the potential consequences of a range of storage accidents with various probabilities of occurring. A brief summary of some of the accidents and assumptions used by sites in preparing the analyses, and the related release or health effects-related results, are shown in Appendix F. Examples of existing analyses applicable to TRUW storage accidents include accidents ranging from breaches of single drums due to drum rupture and lid failure to the total collapse of a storage facility due to a beyond-design-basis earthquake.

The most relevant recent analyses dealing with postulated accidents for TRUW waste storage facilities were reviewed, including the *Waste Isolation Pilot Plant Disposal Phase Draft Supplemental Environmental Impact Statement* (WIPP SEIS-II) (DOE, 1996e). The WIPP SEIS-II considers accidents associated with storage of TRUW after treatment and before further disposition. Accidents during current storage of TRUW are not considered in the WIPP SEIS-II. To allow comparison with other safety analysis of current TRUW storage, it was assumed that the TRUW treated to the planning-basis WAC in the WIPP SEIS-II would be similar in form to that currently stored at the generator sites. The accident scenarios considered in the WIPP SEIS-II include a multiple drum spill, an internally induced drum rupture and fire, and a beyond-design-basis earthquake that results in collapse of the storage facility. Accident consequences were calculated for six sites (Hanford, INEL, LANL, RFETS, ORNL, and SRS). The radionuclide content of each TRUW drum for the first two postulated accidents was assumed to be at the WIPP WAC limit of 80 plutonium equivalent curies (PE-Ci), while the average radionuclide content was applied to the accident involving a beyond-design-basis earthquake.

For the multiple drum spill accident (annual frequency of occurrence of about 0.01) considered in the WIPP SEIS-II, the probability of a latent cancer fatality (LCF) to the offsite MEI ranged from 2E-09 at SRS to 3E-07 at ORNL, with offsite population impacts estimated at less than 1E-03 fatalities. Similarly, the internally induced drum rupture and fire accident considered in the WIPP SEIS-II (annual frequency of occurrence of about 1E-04) also resulted in offsite population impacts of less than 1E-02 fatalities and probabilities of a LCF to the offsite MEI of from 8E-09 at SRS to 1E-06 at ORNL.

Much higher consequences were predicted for the earthquake accident (annual frequency of occurrence of less than 1E-05) considered in the WIPP SEIS-II. The probability of a LCF to the offsite MEI ranged from 2E-03 at SRS to 7E-02 at LANL. The number of latent cancer fatalities in the offsite population ranged from 6 at ORNL and INEL to 200 at Hanford and 300 at RFETS. The high number of fatalities may be attributable to the assumption of a beyond-design-basis earthquake that results in total collapse of the storage structure upon the site's entire inventory of TRUW treated to WIPP-WAC, which produces a significant airborne release of TRUW. In light of the stable nature of treated TRUW, this set of assumptions may be conservative. Consideration of the probability of such an accident results in an offsite MEI cancer risk of less than one in one million.

It should be noted that explicitly analyzing risks from storage would not help to discriminate among most alternatives because of the assumptions used in the WM PEIS. Except for the No-Action Alternative, the WM PEIS assumes that all sites will increase (or at least maintain) their inventories of TRUW for 10 years, until treatment begins. Thus, all sites will have their largest inventories (leading to maximum potential releases during a storage facility accident) regardless of the alternative, with the exception of the No Action Alternative. In that alternative, inventories of TRUW would continue to increase indefinitely.

8.4.3.2 Treatment Facility Accidents

Although there are many possible ways to treat TRUW, technologies using thermal treatment have been the most effective to date (in terms of volume reduction and destruction of organic hazardous constituents). A significant amount of incineration data are available and incineration represents and bounds other thermal treatment processes. Thus, this risk analysis focuses on incineration.[10] Like other TRUW treatment processes, incineration operations and accidents can result in airborne releases of radionuclides. Potential treatment facility accidents identified for all TRUW alternatives include: (1) incineration facility fires or explosions initiated by internal causes; (2) an earthquake or tornado that causes damage and fires in the facility; and (3) the crash of a large or small aircraft into the facility, resulting in fire and explosion. All of these types of accidents can release the radioactive contents from the kiln of the incinerator, the stored ash byproduct from the incineration process, or the trapped contents of the filtration systems in the facility. The accident with the highest potential consequence at each site was evaluated.

The radiological health effects from treatment facility accidents were calculated on the basis of conservative assumptions. Table 8.4–10 summarizes the estimated cancer fatalities resulting from radiation exposures produced by potential treatment facility accidents. This table contains estimates of the cancer fatalities for maximum consequence accidents at each site and of the annual frequency of those accidents. The doses indicated are a function of the severity of the accident and the size of the population affected. The indicated probabilities of an excess cancer are calculated on the basis of the assumption that the accident occurs. Consistent with standard practice in radiological safety analysis, the fatalities are derived only from the cancers associated with radiation. In general, local worker fatalities from trauma in severe accidents would primarily result from the physical effects of the accident (e.g., the initial impact and fire of an airplane crash). These trauma fatalities would tend to be independent of the inventory or process used at a particular site under a given alternative and, therefore, would not tend to be a significant discriminator among the alternatives. Trauma fatalities to the offsite populations from severe accidents would be almost totally independent of the alternative, and therefore would not vary among alternatives.

Assuming that the accident occurs, each of the alternatives poses a cancer fatality probability equal to or greater than one in one million for the offsite MEI at most sites. However, when the frequencies of the accidents are considered, none of the alternatives pose an offsite MEI cancer risk greater than one in one million.

The Centralized Alternative is estimated to produce the highest number of cancer fatalities if an accident occurs affecting the offsite population (seven individuals at the WIPP site). Under Regionalized

[10] This focus gives DOE sufficient information to decide on the location of proposed TRUW treatment and storage facilities. Accident scenarios for all three TRUW treatment trains are assessed in the WIPP SEIS-II (DOE, 1996e). DOE will base its decision on which treatment process it will use to meet the performance standards for WIPP or storage requirements on the analysis in the WIPP SEIS-II.

Table 8.4-10. TRUW Facility Accidents—Radiation-Induced Cancer Fatalities From Maximum Reasonably Foreseeable Potential Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Radiation Dose (rem)	Offsite MEI Cancer Fatality Probability	Offsite Population Radiation Dose (person-rem)	Offsite Population Number of Cancer Fatalities	Worker Radiation Dose (person-rem	WM Workers Number of Cancer Fatalities
Regionalized 2								
Hanford	Incineration, natural phenomena	1.0E-06 to 1.0E-04	2E-03	9E-07	8E+01	*	1E+04	5
Hanford	Incineration explosion	1.0E-06 to 1.0E-04	1E-02	5E-05	4E+03	2	8E+02	*
INEL	Incineration, natural phenomena	1.0E-06 to 1.0E-04	9E-03	5E-06	8E+01	*	4E+02	*
LANL	Incineration, natural phenomena	1.0E-06 to 1.0E-04	1E+00	7E-04	3E+03	1	2E+03	1
RFETS	Incineration, natural phenomena	1.0E-06 to 1.0E-04	2E-02	1E-05	6E+02	*	5E+01	*
SRS	Incineration, natural phenomena	1.0E-06 to 1.0E-04	9E-06	5E-09	3E-01	*	4E+01	*
SRS	Incineration explosion	1.0E-06 to 1.0E-04	5E-04	2E-07	2E+01	*	2E+00	*
Regionalized 3								
Hanford	Incineration, natural phenomena	1.0E-06 to 1.0E-04	2E-03	9E-07	8E+01	*	1E+04	5
Hanford	Incineration explosion	1.0E-06 to 1.0E-04	1E-01	5E-05	4E+03	2	8E+02	*
INEL	Incineration, natural phenomena	1.0E-06 to 1.0E-04	5E-02	3E-05	4E+02	*	2E+03	1
SRS	Incineration, natural phenomena	1.0E-06 to 1.0E-04	9E-06	5E-09	3E-01	*	4E+01	*
SRS	Incineration explosion	1.0E-06 to 1.0E-04	5E-04	3E-07	2E+01	*	2	*
Centralized								
WIPP	Incineration, natural phenomena	1.0E-06 to 1.0E-04	2E+00	1E-03	3E+02	*	2E+05	14
WIPP	Incineration explosion	1.0E-06 to 1.0E-04	1E+02	6E-02	1E+04	7	1E+04	4
Centralized (RH)								
Hanford	Incineration, natural phenomena	1.0E-06 to 1.0E-04	8E-06	4E-09	4E-01	*	6E+00	*
ORNL	Incineration, natural phenomena	1.0E-06 to 1.0E-04	7E-02	3E-05	8E+02	*	3E+01	*

Notes: Natural phenomena refer to accidents initiated either by earthquake or by high wind or tornado, depending on the site and the associated recurrence frequencies. Incineration was the thermal treatment analyzed. * = greater than 0 but less than 0.5. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

Alternative 2, treatment accidents would result in two cancer fatalities in the offsite population at Hanford and one cancer fatality in the offsite population at LANL if the accidents were to occur. Under Regionalized Alternative 3, treatment accidents are estimated to result in two cancer fatalities in the offsite population at Hanford, assuming they occur. No cancer risk fatalities exceeding one within the offsite population would result from accidents under the Centralized Alternative for RH TRUW. The overall risks from accidents for all alternatives, derived by multiplying the health risk value by the frequencies of the accidents, are small.

The highest estimate of cancer fatalities resulting from the maximum reasonably foreseeable accidents affecting waste management workers is 14 at the WIPP site under the Centralized Alternative. Under Regionalized Alternative 2, five cancer fatalities are estimated in the WM worker population at Hanford, and one cancer fatality is estimated at LANL. Under Regionalized Alternative 3, five cancer fatalities are estimated in the WM worker population at Hanford, and one cancer fatality is estimated at INEL. No cancer fatalities within the WM worker population are estimated to result from accidents under the Centralized Alternative for RH TRUW. The overall risks from accidents, taking into account the probability of these accidents, are small.

The results of the WM PEIS analysis are consistent with those in the WIPP SEIS-II (DOE, 1996e). The WIPP SEIS-II examines three levels of treatment: treating to WIPP WAC, thermal treatment using vitrification, and shred and grout. Although the generic treatment train evaluated in the WM PEIS for meeting RCRA land disposal restrictions (Figure 8.2-3) does not include vitrification as a treatment technology, comparison of the accident analyses impacts in the WM PEIS with those estimated in the WIPP SEIS-II indicates that the largest potential impacts from accidents are associated with thermal treatment. The accident analysis for thermal treatment to LDRs in the WIPP SEIS-II considers three scenarios: failure of a drum containing vitrified treated waste, a steam explosion in a vitrification glass melter, and a beyond-design-basis earthquake with resultant collapse of the waste treatment facility. The accident associated with TRUW treatment with the highest potential consequence to the offsite population for both the WM PEIS and WIPP SEIS-II is a seismic event. For this event, the WM PEIS predicts up to 7 latent cancer fatalities in the offsite public, depending upon the alternative and site; the WIPP SEIS-II predicts up to 30 LCFs in the offsite population. The difference in consequences for this seismic event between the WIPP SEIS-II and the WM PEIS can be attributed to the use of different analytical methods and assumptions and their attendant uncertainties. As an example, the WIPP SEIS-II very conservatively assumes that the entire process inventory would be affected by this accident, while the WM PEIS assumes 24% of the process inventory, based upon recent safety literature. Therefore it may be expected that the WIPP SEIS-II would predict generally higher consequences for a seismic-initiated treatment facility accident. The maximum probability of a LCF to the offsite MEI is on the order of 0.06 for the Centralized Alternative at WIPP in the WM PEIS and 0.02 for ORNL in the WIPP SEIS-II.

The health risk consequences presented in Table 8.4–10 are conservative. They assume no mitigation of the accidents and take no credit for emergency response actions. The reduction in impacts due to these mitigation actions would be significant.

8.5 Air Quality Impacts

The management of TRUW would not appreciably affect the air quality at most sites. No criteria air pollutant emissions would exceed standards at any site. Emissions of radionuclides were estimated to be below the applicable standards at all sites, except for LANL and WIPP when these sites treat TRUW to meet LDRs. The exceedances at these sites would require mitigation measures to reduce emissions to acceptable levels. Emissions of other hazardous air pollutants were estimated to be below the applicable standards at all sites.

As illustrated in Table 8.5–1, DOE evaluated air quality impacts at each proposed TRUW treatment site on the basis of estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (which include radionuclides), and toxic air pollutants. Emissions from TRUW facility construction and operation and maintenance activities were estimated.

The Clean Air Act (42 USC 7401 *et seq.*) regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new emissions from both "stationary" (e.g., treatment and storage facilities) and "mobile" (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule" (GCR). In this rule, EPA has established limits for each criteria air pollutant in nonattainment areas. An entity which would engage in an activity that would result in emissions that equals or exceeds those limits in a nonattainment area must first obtain a permit.

Table 8.5–1. Air Quality Impacts Evaluated for TRUW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Were Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Table 8.5–2
	Operations	Estimated for thermal treatment units, for fuel use by all other TRUW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Table 8.5–3
Radionuclide emissions	Operations	For all TRUW treatment facilities	Percent of standard	Table 8.5–4
Hazardous and toxic air pollutant emissions	Operations	For all TRUW treatment facilities	Percent of standard	Text discussion only

In "attainment areas" (where air pollution standards are met), only new emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. However, a permit is required for a new stationary source if it equals or exceeds the allowable increase. Permits are not required for criteria pollutant emissions from mobile sources.

8.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers drive to the construction site—"mobile sources."

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities under the TRUW alternatives would result in emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. Table 8.5–2 lists those sites. DOE chose the 10%

> ***Major Types of Air Pollutants***
>
> - ***Criteria Air Pollutants:*** *carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*
> - ***Hazardous Air Pollutants:*** *189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*
> - ***Toxic Air Pollutants:*** *Other toxic compounds regulated by EPA and state or local governments*

Table 8.5–2. TRUW Sites Equaling or Exceeding 10% of Standard for Criteria Air Pollutants During Construction[a]

Alternative	Number of Sites: CH Treat	Number of Sites: RH Treat	Treatment Standard[b]	ANL-E: NO_2	ANL-E: VOC	RFETS: CO	RFETS: NO_2
No Action[c]	11	5	WIPP-WAC				
Decentralized[d]	16	5	WIPP-WAC	49(23/26)	17(2/15)	19(3/16)	11(8/3)
Regionalized 1	5	2	Reduce gas	40(16/24)	16(2/14)	20(3/17)	11(8/3)
Regionalized 2	5	2	LDRs	34(25/9)		29(4/25)	15(10/5)
Regionalized 3	3	2	LDRs	34(25/9)			
Centralized	WIPP	2	LDRs	34(25/9)			

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; NO_2 = nitrogen dioxide; VOC = volatile organic compounds; CO = carbon monoxide.
[a] Sites that exceed 10% of the limit specified by the GCR; total % of limit (% equipment/% worker vehicles). Blanks indicate that a site does not exceed 10% of the standard under the specified alternative.
[b] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce volatile gas generation; LDRs = Land Disposal Restrictions criteria.
[c] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[d] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

threshold to identify those sites where criteria air pollutant emissions could result in adverse air quality impacts.

As indicated in Table 8.5–2, two of the 13 major TRUW sites are located in nonattainment areas and, as a result of construction of TRUW facilities, would release emissions that exceed 10% of the allowable limit for a particular criteria air pollutant. Both sites would exceed the 10% threshold in the Decentralized and Regionalized Alternatives 1 and 2. However, DOE estimates that emissions from construction activities would not exceed the allowable levels at any site under any alternative.

8.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants are also emitted during operations and maintenance (O&M) of TRUW facilities (stationary sources) and by vehicles driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rule in nonattainment areas or PSD increments in attainment areas).

As shown in Table 8.5–3, three of the 13 major TRUW sites would exceed 10% of applicable air pollutant emission standards. Of these, one site is located in a nonattainment area, and two sites are in attainment areas. Two sites would have pollutant emissions that exceed 10% of the levels under any alternative. No site is estimated to exceed applicable standards, and therefore, no site would need to obtain a Clean Air Act permit.

Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). No site was estimated to equal or exceed 10% of the standards.

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 kilometers of a PSD Class I area. Eight

Table 8.5–3. Percent of Sites' Allowable Air Emissions Discharged During Operations—TRUW Sites Equaling or Exceeding 10% of Standard [a]

Alternative	Number of Sites		Treatment Standard [b]	Criteria Pollutants			
				Operation and Maintenance			
	CH Treat	RH Treat		INEL	RFETS	WIPP	
				PM_{10}[c]	CO[d]	NO_2[c]	PM_{10}[c]
No Action[e]	11	5	WIPP-WAC				
Decentralized[f]	16	5	WIPP-WAC		17(0/17)		
Regionalized 1	5	2	Reduce gas		20(0/20)		
Regionalized 2	5	2	LDRs	10	24(0/24)		
Regionalized 3	3	2	LDRs	17			
Centralized	WIPP	2	LDRs			15	25

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW; CO = carbon monoxide; NO_2 = nitrogen dioxide; PM_{10} = particulate matter less than or equal to 10 micrometers in diameter. Blanks indicate that a site does not exceed 10% of the standard under the specified alternative.
[a] Sites equaling or exceeding 10% of the PSD increment or the standard specified by the General Conformity Rule, as indicated.
[b] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce gas generation potential; LDRs = Land Disposal Restrictions criteria.
[c] Attainment area for this pollutant; PSD regulations are applied; total % represents stationary-source emissions only.
[d] Nonattainment area for this pollutant; General Conformity regulations are applied; total % (% stationary-source/% mobile-source).
[e] For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[f] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

sites proposed for TRUW activities under various alternatives are located within 100 km of a PSD area: INEL, LANL, LLNL, NTS, ORR, RFETS, SNL-NM, and WIPP. None of the proposed TRUW activities would emit enough criteria pollutants to affect a PSD Class I area.

8.5.3 Hazardous and Toxic Air Pollutant Emissions

Thermal treatment of TRUW will result in emission of small quantities of hazardous (including radionuclides) and toxic air pollutants. Nonradiological hazardous air pollutants and toxic air pollutants were evaluated by comparing estimated ambient concentrations to EPA guidelines and State Ambient Allowable Limits (AALs) for each site. Radionuclides were evaluated by comparing the annual MEI radiation dose to the National Emissions Standards for Hazardous Air Pollutants (NESHAP)—10 millirem per year (40 CFR 61).

As shown in Table 8.5–4, doses from airborne radionuclides were estimated not to equal or exceed 10% of the dose standard at any site, except at INEL, LANL, and WIPP. The dose standard was exceeded at LANL and WIPP. These results are from the assumed thermal treatment with generic technology of waste containing plutonium-238 at WIPP and americium-241 at INEL and LANL. The treatment of TRUW with these radionuclides would require special design and other considerations, including additional control measures to reduce emissions to acceptable levels. Nonradiological hazardous or toxic air pollutant concentrations at the proposed treatment sites were not estimated to equal or exceed 10% of the applicable guidelines or standards.

8.6 Water Resources Impacts

Major impacts to water resources at the sites are unlikely for treatment of TRUW under any of the alternatives.

As illustrated in Table 8.6–1, DOE analyzed the impacts on water resources of treatment activities. DOE evaluated the effects on water availability from building and operating treatment facilities.

Table 8.5-4. TRUW Sites Equaling or Exceeding 10% of Standard for Radionuclides During Operation

Alternative	Number of Sites		Treatment Standard[a]	Radionuclides		
	CH Treat	RH Treat		INEL	LANL	WIPP
No Action[b]	11	5	WIPP-WAC			
Decentralized[c]	16	5	WIPP-WAC			
Regionalized 1	5	2	Reduce gas			
Regionalized 2	5	2	LDRs		134	
Regionalized 3	3	2	LDRs	10		
Centralized	WIPP	2	LDRs			137

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW. Blanks indicate that a site does not exceed 10% of the standard under the specified alternative.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce gas generation potential; and LDRs = Land Disposal Restrictions criteria.
[b] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

Table 8.6-1. Water Resource Impacts Evaluated for TRUW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Table 8.6-2
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used: • by personnel • by treatment processes	Percent increase in current water use	Table 8.6-2
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

8.6.1 WATER AVAILABILITY

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of TRUW facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite stream at a given site.

Table 8.6–2 identifies sites where projected water usage under any alternative would increase by more than 1%. This 1% threshold is based on the assumption that lesser changes are not likely to have significant impacts.

Five of the 13 major sites are predicted to exceed the 1% threshold. Most exceedances are due largely to water used during the 2- to 3-year period for construction of treatment facilities. Although projected water requirements exceed current water use by more than 1% at INEL, LLNL, RFETS and SRS, these sites are not likely to experience adverse impacts because of sufficient capacities and the relatively small amount of additional water needed (DOE, 1996b).

Adverse impacts could be experienced at WIPP. As shown in the site data tables in Volume II, additional water use for the Centralized Alternative would be approximately 290% of current use of 15,000 gallons per day during the 2- to 3-year construction period and 110% of current use during operations. This appears high, but the capacity of the water supply system at WIPP was designed to allow for increased water demand if TRUW is disposed of there. Water use under the Centralized Alternative would require an additional 8% of the 540,000 gallons per day capacity of the water supply distribution system during

Table 8.6-2. TRUW Sites Predicted to Exceed 1% of Current Water Use for Construction or Operations

Alternative	Number of Sites		Treatment Standard[a]	INEL	LLNL	RFETS	SRS	WIPP
	CH Treat	RH Treat						
No Action[b]	11	5	WIPP-WAC					
Decentralized[c]	16	5	WIPP-WAC	1.2	2.8	2.1		
Regionalized 1	5	2	Reduce gas	1.2	2.8	2.2	1.2	
Regionalized 2	5	2	LDRs	1.3	2.8	3.0	1.4	
Regionalized 3	3	2	LDRs	1.4	2.8		1.4	
Centralized	WIPP	2	LDRs		2.8			290

Notes: CH = contact-handled TRUW; RH = remote-handled. Blank cells are less than or equal to 1%. Water sources are as follows: groundwater for INEL, LLNL, SRS; municipal water supply for RFETS and WIPP.

[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce gas generation potential; and LDRs = Land Disposal Restrictions criteria.

[b] For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, impacts are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.

[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

construction and 3% during operations. WIPP does not withdraw water from any onsite surface water or groundwater body. Instead, water is supplied by municipal water via a pipeline from the city of Carlsbad, New Mexico. Because water for WIPP is supplied by an offsite municipal system, onsite water resources would not be affected.

As shown in the site data tables in Volume II, water use would be less than 1% of the average flow in the surface water body for DOE sites that withdraw water directly from a surface water source (Hanford, ORR, PGDP, and WVDP). In addition, it was assumed for this analysis that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (ANL-E, ORR, PGDP, RFETS, SRS, and WVDP), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These negligible changes in flow should not affect surface water availability.

8.6.2 Water Quality

Impacts to groundwater quality from disposal of TRUW were not evaluated because disposal of TRUW is not within the scope of the WM PEIS.

8.7 Ecological Resources Impacts

Loss of limited acreage of habitat at some sites from construction site clearing for TRUW facilities should not affect populations of nonsensitive plant and animal species because these species' habitats are well established regionally. DOE should be able to locate new TRUW facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction sites are small compared to the total acreage at each site suitable for waste operations. A screening level risk assessment of TRUW facility airborne emissions indicated that terrestrial wildlife species are not likely to be affected. Transportation accidents leading to spills of TRUW into aquatic environments are not expected to have serious short- or long-term consequences under any alternative.

DOE analyzed the effects of construction site clearing to build TRUW treatment and storage facilities at the 10 major TRUW sites and the operation of treatment facilities on terrestrial ecological resources at proposed TRUW management sites (Table 8.7–1). Accidental releases during transportation of TRUW between DOE sites that could affect aquatic resources offsite were also evaluated.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the WM PEIS will not be the basis for selecting specific locations for facilities at the sites. When selecting locations for facilities at sites, DOE will consider the results of relevant existing or new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

8.7.1 General Impacts of Site Clearing

None of the TRUW alternatives would require extensive clearing for construction of TRUW facilities. No more than 29 acres would be disturbed at any site under any alternative. These acreage requirements are small compared to the regional extent of habitat for nonsensitive species on or near the sites. Although site clearing would destroy individual plants and would kill or displace individual animals (particularly small

Table 8.7–1. Ecological Resources Impacts Evaluated for TRUW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at TRUW construction sites to general habitat range	Text discussion
Terrestrial species exposures	Terrestrial animal species	Comparison of estimated radiation dose of representative species with toxicity standard	Text discussion
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats by comparing construction acreage to available acreage of nonsensitive habitats	Text discussion
Sensitive species concerns	Federally- and State-listed endangered and threatened species	Numbers of Federally- and State-listed species displayed by site/alternative	Table 8.7–2
Effects of transportation accidents	Aquatic species in streams crossing transportation corridors	Results of scenario-based modeling analysis of accidental spill effects on fish in various size streams	Text discussion

mammals and song birds with limited home ranges), no effects on populations of these species are expected from proposed TRUW actions because nonsensitive species habitats are well established regionally.

8.7.2 Site Clearing Effects on Sensitive Habitats

WIPP has no sensitive habitats on or adjacent to the site; the other TRUW sites do contain sensitive habitats. The degree to which the habitats may be affected by noise or vibration, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby construction activities at any site depends on DOE's ability to avoid siting facilities near these habitats. A measure of this ability is the percentage of available land required for facility construction under an alternative. Available acreage was estimated from site development plans, either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage required for the TRUW facilities ranged from 0.003% at SRS under the Centralized Alternative to 0.41% at the Hanford Site under Regionalized Alternatives 2 and 3. Considering the small amounts of available land required for TRUW facilities, DOE should have a great degree of flexibility in siting these facilities and should be able to employ a range of mitigative measures so that site clearing to implement any of the alternatives for TRUW management should not affect adjacent sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff of water and soil to surface waters from construction sites. However, proper construction practices should minimize these effects. Direct discharges to surface waters from the routine operation of treatment facilities would comply with applicable regulations and would be limited by the use of accepted engineering techniques. Therefore, the impacts to aquatic organisms are expected to be minimal.

8.7.3 EFFECTS OF TRUW TREATMENT FACILITY EMISSIONS

DOE used atmospheric emissions and deposition modeling to estimate the toxicity to terrestrial animals from airborne emissions of radionuclides from treatment facilities. This analysis used the same atmospheric emissions estimates as the human health risk assessment and provided estimates of radionuclides deposited on surface soils.

For this analysis, DOE examined those sites with the highest anticipated emissions. Potential toxicity to terrestrial wildlife was analyzed for selected sites under the Decentralized Alternative, Regionalized Alternatives 2 and 3, and the Centralized Alternative. The radionuclides Cs-137, H-3, Ni-63, Co-60, Sr-90, U-238, Pu-238, Pu-239, Pu-241, Y-90, Am-241, Pm-147, and Ba-137 were selected for the analysis. These radionuclides constitute 80% of the total activity of all radionuclides expected to be emitted. The remaining 20% of the radioactivity comes from smaller emissions of a large number of radionuclides. The conservative assumptions used to characterize the exposure scenario for wildlife (e.g., accumulation of contaminants for 10-year period with no loss due to decay or transport) compensate for limiting the analyses to 80% of the released activity. The concentrations of radionuclides were used in calculating Hazard Indexes for each selected combination of sites and alternatives as composite ratios between the estimated exposures of species to each contaminant and the estimated contaminant-specific toxic levels. A Hazard Index greater than 1 indicates a potential for the combined exposures to adversely affect the health of terrestrial species. For all Alternatives at all sites, the Hazard Index was determined to be less than 0.01, except at WIPP under the Centralized Alternative, where the maximum estimated dose produces a maximum estimated Hazard Index of 0.11. Therefore, impacts to terrestrial receptor populations as a result of emissions of radionuclides from treatment facilities are expected to be minimal. Additional information on the methods used to assess potential toxicity to terrestrial animals and on the results of the analysis is presented in Section C.4.4 of Volume III and the impacts technical report (DOE, 1996b).

8.7.4 CONSIDERATION OF SENSITIVE SPECIES

For comparison of the TRUW management program's potential to affect sensitive species, Table 8.7–2 lists the numbers of Federally and State-listed sensitive species occurring or potentially occurring at the 10 largest TRUW sites under each alternative. DOE anticipates that, in the majority of cases, any such impacts found significant in sitewide or project-specific NEPA reviews can be mitigated or eliminated by alteration of a proposed facility's location or other measures.

8.7.5 EFFECTS OF TRUW TRANSPORTATION ACCIDENTS

The ecological impacts of a transportation accident involving shipment of TRUW were analyzed on the basis of an assumed accident involving a release of TRUW from a vehicle into a stream. Analysis of such an accident requires an estimate of the spill release rate and assumed stream characteristics. The impacts of waste transportation accidents were evaluated as consequence assessments that did not include estimates of the probability of occurrence of these events. The transportation accident scenario involved spilling the

Table 8.7–2. Numbers of Federally Listed and State-Listed Endangered and Threatened Species Occurring or Potentially Occurring at the TRUW Sites (Federal/State)

Alternative	Number of Sites CH Treat	Number of Sites RH Treat	Treatment Standard[a]	ANL-E	Hanford	INEL	LANL	LLNL	NTS	ORR	RFETS	SRS	WIPP
No Action[b]	11	5	WIPP-WAC	2/5	3/11	2/2	2/4	6/5	2/2	1/11	2/2	8/8	--
Decentralized[c]	16	5	WIPP-WAC	--	3/11	--	2/4	--	2/2	1/11	--	--	--
Regionalized 1	5	2	Reduce gas	--	3/11	2/2	2/4	--	--	1/11	--	8/8	--
Regionalized 2	5	2	LDRs	--	3/11	2/2	2/4	--	--	1/11	2/2	8/8	--
Regionalized 3	3	2	LDRs	--	3/11	2/2	--	--	--	1/11	2/2	8/8	--
Centralized	WIPP	2	LDRs	--	3/11	--	--	--	--	1/11	--	--	2/5

Notes: CH = contact-handled TRUW; RH = remote-handled; -- = no major action proposed at a site under the specified alternative.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce volatile gas generation; and LDRs = Land Disposal Restrictions criteria.
[b] For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. For all other alternatives, disposal at WIPP is assumed.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

contents of a TRUW shipment being transported by rail to the Hanford Site or LANL into streams of different sizes. As a result of the packaging used to transport TRUW, it was assumed that only a small fraction of the total inventory of TRUW (approximately 6 kg [14 lb.] out of a single shipment weight of 28,000 kg [61,000 lb.] of RH-TRUW, or 0.02%) would be released into the streams in an accident, as a result of small cracks and potential seal failures in the packaging containers (see Section 8.2.4).

The results of this analysis indicate that even if the entire release were concentrated in 1 cubic meter (m^3) of surface water, the dose to aquatic organisms would be at least five orders of magnitude below the National Council on Radiation Protection and Measurements recommended safe level. If spills were deposited in stream sediments, a few kilograms of sediment, at most, would be significantly contaminated. Since the total estimated release of radioactivity is less than 0.5 curie in the scenarios evaluated, it is unlikely that the released material would be detected above background radiation levels after its initial dispersal. In addition, impacts from the release of hazardous constituents are expected to be minor due to the small fraction of waste released. Additional information on the methods used to assess the potential consequences of a TRUW transportation accident on aquatic environments and on the results of the analysis is presented in Section C.4.4 of Volume III and the impacts technical report (DOE, 1996b).

8.8 Economic Impacts

Nationwide, the largest economic effects of TRUW management would occur under Regionalized Alternative 2 and would generally decrease as the alternatives become more centralized. The greatest benefit at any site occurs when TRUW is managed at that site. The greatest increase in jobs as a percent of regional employment would occur at INEL and WIPP under Regionalized Alternative 3 and the Centralized Alternative, respectively. None of the TRUW alternatives would substantially affect the national economy, although some 1,850 to 11,900 jobs would be directly or indirectly created.

DOE estimated the effects of expenditures for TRUW management on the local and national economies (see Table 8.8–1). Local economic effects were based on direct expenditures at each site for construction, operation and maintenance, and decontamination of treatment facilities. The socioeconomic region of influence (ROI), where local effects were evaluated, consists of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data for the ROI counties. Local jobs and personal income were considered to be substantial benefits when they were

Table 8.8-1. Economic Impacts Evaluated for TRUW Alternatives

Economic Impact Analyzed	Affected Economic Resource	Analysis Method	Presentation of Results
Increased regional employment	Regional employment	Proposed site expenditures multiplied by regional employment multiplier at each TRUW site	Table 8.8-2
Increased regional incomes	Regional per capita income	Proposed site expenditures multiplied by regional income multiplier at each TRUW site	Text discussion
National economic effects	National economy	Proposed site plus total transportation expenditures multiplied by national employment and income multipliers	Text discussion

1% or greater than the 1990 baseline. Transportation expenditures were considered at the national level only.

Local economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined to estimate total project effects at each site over 24 years. For all alternatives (except No Action), the construction phase at any site was assumed to take 4 years; the operations phase was assumed to take 15 years (a 10-year operations and maintenance period and a 5-year decontamination period); and 5 years was assumed to account for the continued effects on employment and income after each project phase ended. Job and personal income increases are shown for each site in the site tables in Volume II.

Across the alternatives, only regions surrounding the Hanford Site, INEL, LANL, and WIPP would experience a 1% or greater change in the number of jobs as a result of expenditures for TRUW management (Table 8.8-2). The Hanford Site would experience an increase in the number of direct, indirect, and induced jobs of 1% under Regionalized Alternatives 2 and 3, and LANL would experience a 1% change under the Decentralized and Regionalized 1 and 2 Alternatives. The increases in the number of new direct, indirect, and induced jobs were greatest at INEL and WIPP under the Regionalized 3 and Centralized Alternatives, respectively, showing a 2.1% change in the number of jobs. No sites would experience a 1% or greater increase in personal income under any of the alternatives.

Table 8.8-2. Employment Resulting From the Management of TRUW as a Percent of Regional Employment (sites where jobs were estimated to be 1% or more of the regional baseline)

Alternative	Number of Sites		Treatment Standard[a]	Hanford	INEL	LANL	WIPP
	CH Treat	RH Treat					
No Action[b]	11	5	WIPP-WAC				
Decentralized[c]	16	5	WIPP-WAC		1.4	1.0	
Regionalized 1	5	2	Reduce gas		1.6	1.0	
Regionalized 2	5	2	LDRs	1.0	1.8	1.1	
Regionalized 3	3	2	LDRs	1.0	2.1		
Centralized	WIPP	2	LDRs				2.1

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW. Blanks indicate sites where jobs were estimated to be less than 1% of the regional baseline.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce gas generation potential; and LDRs = Land Disposal Restrictions criteria.
[b] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. For all other alternatives, disposal at WIPP is assumed.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage, and then to WIPP for disposal.

The sum of the new direct, indirect, and induced jobs across the alternatives at 10 sites' ROIs range from approximately 1,250 (under the No Action Alternative) to 7,700 (under Regionalized Alternative 2). At the four sites listed in Table 8.8-2, job increases are in line with increases in the volume of TRUW managed at each site under the alternatives. These employment increases of up to 2.1% could be considered important benefits of TRUW management at those sites.

Under the No Action Alternative, in place of distinct construction and operations phases, all costs were assumed to occur in 25 years (20 years of storage operations plus 5 years for decontamination and decommissioning).

In addition to analyzing the effects on regional economies, DOE analyzed these effects on the national economy. None of the TRUW Alternatives would have substantial impacts on the national economy. The No Action Alternative has no construction activities, and therefore no construction impacts. The total number of jobs generated in the national economy from combined weighted construction and operations activities ranges from approximately 1,850 (under the No Action Alternative) to 11,900 jobs (under

Regionalized Alternative 2). In absolute terms, the number of jobs appears large, but 11,900 jobs represents only 0.009% of the 137 million jobs in the national economy. Similarly, the change in personal income due to the implementation of any of the alternatives ranges from $42 million (under the No Action Alternative) to $270 million (under Regional Alternative 2). This $270 million represents only 0.006% of the $4.7 trillion total personal income in the U.S. economy. The changes would likely represent a shift in the source of income from previous employment to employment in TRUW projects rather than a net increase in national personal income.

8.9 Population Impacts

No major population increases are expected to occur at any site under any alternatives; thus, community characteristics and the provision of services would not be affected.

Potential population changes in ROIs were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used to evaluate the likelihood that associated effects, such as changes in community size and diversity, and the provision of necessary services, would be caused by such population changes.

No regions around any TRUW site would experience population increases greater than 1% of the current ROI population. Three sites are in regions that would experience an estimated population increase of more than 0.5%, which DOE believes would have a potential for minor social impacts—for INEL under the Decentralized and Regionalized Alternatives 1, 2, and 3, and WIPP under the Centralized Alternative.

8.10 Environmental Justice Concerns

Assessment of potential concerns regarding environmental justice associated with TRUW management indicated potential concerns about disproportionately high and adverse health risks or environmental impacts to minority and low-income groups at the INEL and WIPP sites. These potential impacts could be mitigated by selection of an alternative facility location or treatment technology, or the use of more efficient emissions controls.

The analysis of environmental justice concerns related to the management of TRUW was based on a review of the impacts reported in this chapter. This analysis was performed to reveal the potential for disproportionately high and adverse human health or environmental impacts on minority or low-income populations near each of the 13 major sites that might treat TRUW. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done. Appendix C also provides maps illustrating the distribution of minority and low-income populations within 50 miles of each of the 13 sites.

8.10.1 Results

From the standpoint of environmental justice, the potential for disproportionately high adverse human health effects from exposures to radionuclide emissions from TRUW treatment facility operations is low for most TRUW management alternatives and for all TRUW sites except INEL and WIPP. Incident-free TRUW storage and treatment facility operations present no significant risk and do not constitute a reasonably foreseeable adverse impact to the surrounding population of any site.

For the offsite population MEI during incident-free facility operations, screening criteria indicated a cancer fatality probability equal to or greater than 1.0E–06 at Hanford, INEL, LANL, ORR, RFETS, and WIPP for treatment to LDRs. Demographic analysis of the ROIs of these six sites indicated potential disproportionate effects at INEL under the Regionalized 3 Alternatives and at WIPP under the Centralized Alternative. The MEI would be located in a census tract at INEL that contains a low-income population proportion (20.3%) greater than the national average of 13.1%. The MEI at WIPP would be located in a census tract with a minority population proportion (69.7%) that exceeds the national average (24.4%) and a low-income population proportion (23.6%) that also exceeds the national average (13.1%).

It should be noted that use of an alternative treatment technology or employment of more efficient emissions controls than the controls assumed in the conceptual thermal treatment analyzed in the WM PEIS would enable DOE to treat TRUW with lower health risks to the nonworker MEI.

A more detailed analysis of potential concerns regarding environmental justice impacts would be conducted in NEPA reviews on site-specific activities involved in treating and storing TRUW.

8.10.1.1 Transportation

Incident-free TRUW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects on minority or low-income populations. As Section 8.4.2 indicates, the estimated total number of cancer fatalities resulting from incident-free transportation is zero under the No Action Alternatives and two under all other TRUW alternatives. These estimates of collective population fatalities are for the total of all shipments. Disproportionate shares of minority and low-income populations reside near interstate highways and railroads; however, the major routine risk to the public from truck transportation is from exposure during rest stops to travelers who are using the same rest stops. Minority and low-income populations are found to be disproportionately lower in use of highway rest stops (DOT, 1992). For rail shipments, the primary risks to the public would be from radiological exposure during railcar classification in railyards, primarily at the start and end of each shipment, and from the emission of diesel exhaust from the trains in urban areas. Therefore, disproportionately high and adverse health effects to minority or low-income populations from incident-free TRUW transportation are not expected to occur.

The expected number of cancer fatalities due to radiation exposure resulting from transportation accidents, taking into account both the consequences of such a release and the probability that an accident causing such a release will occur, is less than 0.5 under all alternatives. The expected number of transportation accident fatalities from trauma is approximately three under all TRUW alternatives except No Action, which would have none. Consequently, disproportionately high and adverse impacts on minority and low-income populations are not expected.

8.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 8.10.1 did not indicate any adverse impacts to water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Air quality impacts are possible at three sites but no disproportionately high and adverse impacts are expected for any segment of the population.

8.11 Land Use Impacts

Because land requirements for TRUW facilities are relatively small, no impacts on current onsite land uses are expected. Site development plans indicate no potential conflicts between proposed treatment or storage facilities and other plans for the sites.

DOE examined the impacts of the alternatives on land use by comparing the acreage required for new treatment and storage facilities to the acreage either designated for waste operations or suitable for development (see Table 8.11–1). Suitable land is the total site acreage, minus the acreage of known cultural resources, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Site development plans were also used to identify potential conflicts between the facilities proposed under each alternative and plans for future uses of the site.

None of the site development plans indicated any conflicts between TRUW management and other uses. Because the analysis showed that TRUW facilities would require less than 1% of the land available for waste operations at any site, DOE would have considerable flexibility in locating those facilities, and impacts on land use would probably be minimal. (See the site data tables in Volume II for percentage of waste operations area.) For the same reason, conflicts with adjacent offsite land use plans are considered unlikely.

Table 8.11–1. Land Use Impacts Evaluated for TRUW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each TRUW site	Land use shown in site development plans	Comparison of waste management required land acreage with amount designated (or estimated) for waste management in site development plan	Text discussion
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed waste management uses and nearby land uses	Text discussion

Although DOE intends to select sites for waste management on the basis of the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities at those sites. When selecting locations for facilities at sites, DOE will consider the results of relevant existing or new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations on a site.

8.12 Infrastructure Impacts

Although no offsite infrastructure impacts are expected, proposed TRUW activities would affect onsite infrastructure at Hanford, INEL, and WIPP. In addition, increases in site employment at the Hanford Site, INEL, LANL, and WIPP would lead to traffic increases that would be sufficient to affect onsite transportation infrastructure. The greatest infrastructure impacts are expected at WIPP under the Centralized Alternative.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and power under the alternative configurations for TRUW management (see Table 8.12–1). Water and power requirements were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because construction wastewater was assumed to be negligible.

Table 8.12–1. Infrastructure Impacts Evaluated for TRUW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support TRUW facilities	Capacity of onsite water, power, and wastewater systems	Add increased TRUW facility use to current use—compare to current capacities	Table 8.12–2
	Onsite transportation infrastructure	Compare new site employment with current site employment as an index of increased stress	Table 8.12–3
Capacity of community infrastructure to support increased worker populations and their families	Regional water, power, wastewater treatment, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion only

Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment (Table 8.12-2) was used as an indicator of potential impacts to onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population through in-migration of workers as an indicator of increased demand on community infrastructure.

Table 8.12–3 shows the increase in onsite demand for water, wastewater treatment, and power at sites where the increase exceeds 5%. The potential for a major impact is assumed to exist where an increase of 5% or greater causes total demand to exceed 90% of capacity. A moderate impact is assumed where total demand remains below 90% of capacity.

As shown in Table 8.12–3, with the single exception of WIPP under the Centralized Alternative, all of the onsite infrastructure impacts relate to demand for wastewater treatment or power. Wastewater treatment impacts would occur at Hanford under the Decentralized and all Regionalized Alternatives. Electrical power impacts would occur at INEL under all Regionalized Alternatives and the Centralized Alternative. The

Table 8.12–2. Percent Increase in Site Employment From Construction of TRUW Facilities (sites with employment increases equal to or greater than 5%)

Alternative	Number of Sites		Treatment Standard[a]	Hanford	INEL	LANL	WIPP
	CH Treat	RH Treat					
No Action[b]	11	5	WIPP-WAC				
Decentralized[c]	16	5	WIPP-WAC	6	6	7	
Regionalized 1	5	2	Reduce gas	7	7	8	
Regionalized 2	5	2	LDRs	9	9	7	
Regionalized 3	3	2	LDRs	9	11		
Centralized	WIPP	2	LDRs	6			**162**

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW. Bold indicates potential for major effects on transportation infrastructure onsite. Blank cells indicate an increase of less than 5%.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce volatile gas generation; and LDRs = Land Disposal Restrictions criteria.
[b] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, impacts are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP will occur, but the alternatives do not include disposal actions.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for interim storage.

Table 8.12-3. Increase in Demand for Water, Wastewater, or Power as a Percent of Current Capacity—TRUW (sites with increases exceeding 5%)

Alternative	Number of Sites		Treatment Standard[a]	Hanford	INEL	WIPP
	CH Treat	RH Treat				
No Action [b]	11	5	WIPP-WAC			
Decentralized [c]	16	5	WIPP-WAC	Wastewater (5.9)		
Regionalized 1	5	2	Reduce gas	Wastewater (7.0)	Power (6.4)	
Regionalized 2	5	2	LDRs	Wastewater (7.8)	Power (6.6)	
Regionalized 3	3	2	LDRs	Wastewater (7.8)	Power (6.6)	
Centralized	WIPP	2	LDRs		Power (6.6)	Water (7.7) Wastewater (82) Power (50.0)

Notes: CH = contact-handled TRUW; RH = remote-handled TRUW. Blanks indicate increases of 5% or less.
[a] Treatment standards include WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; Reduce gas = intermediate TRUW treatment to reduce volatile gas generation; and LDRs = Land Disposal Restrictions criteria.
[b] For the No Action Alternative, storage is indefinite; no disposal at WIPP is assumed. However, impacts are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.
[c] In the Decentralized Alternative, TRUW is processed at all 16 sites then transferred to 10 sites for storage, and then to WIPP for disposal.

greatest impacts on water demand, wastewater treatment, and power would occur at WIPP under the Centralized Alternative. A 7.7% increase in WIPP's demand for water is expected to have a moderate impact on water supply under this alternative. A moderate to major impact on wastewater treatment would also occur, increasing the current demand for treatment by 82%.

A further evaluation found that this increase might exceed the capacity of the current treatment system by 61%. Current power demand at WIPP would increase by 50%, although this increase would not cause total power demand to exceed 90% of current capacity. If new construction were needed to increase the power system's capacity, additional environmental impacts and costs might result.

Although DOE intends to select sites for waste management on the basis of the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities at the sites. When selecting locations for facilities at sites, DOE will consider the results of relevant existing or new sitewide or project-level NEPA analyses, which would evaluate potential impacts on infrastructure at specific sites.

8.13 Cultural Resources Impacts

Construction and operation of TRUW facilities could adversely affect cultural resources. Cultural resources surveys would be conducted at the site before construction would begin; however, protection measures would be identified and implemented.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where treatment and storage facilities for TRUW are proposed. Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys at the 16 proposed TRUW sites and the reported resources at those sites. However, the impacts of the construction of TRUW facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends on identifying specific locations for proposed facilities at a site.

Although DOE intends to select sites for waste management on the basis of the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities at those sites. When selecting locations for facilities at sites, DOE will consider the results of relevant existing or new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources at particular locations on a site.

Land requirements for the construction of TRUW facilities are sufficiently small under all alternatives that DOE would probably have enough flexibility in siting them to avoid impacts on cultural resources. If not, measures would be taken to protect these resources.

8.14 Costs

Costs increase as the level of treatment increases. Treatment to meet WIPP-WAC costs about the same as treatment to reduce gas generation potential. Treatment to meet LDRs costs approximately 22% more than the two less intensive treatments. Transportation costs are lower than facility costs, making shipment to available facilities at other sites generally less expensive than building a new facility at a site.

As indicated in Table 8.14–1, DOE estimated costs for building and operating treatment and storage facilities, and for transportation (INEL, 1995a,b). DOE evaluated costs associated with TRUW management from both a life-cycle and process perspective using 1994 dollars.

8.14.1 LIFE-CYCLE COSTS

DOE evaluated facility costs for four phases of the life-cycle of facilities and their operations: pre-operations, construction, O&M, and decontamination and decommissioning. Life-cycle costs do not include speculative factors such as impacts to long-term land value.

- Costs for pre-operation activities consist of technology and site adaptation, including bench-scale tests and pilot plant demonstrations; permitting; plant startup and cold-run costs; and related conceptual design, safety analysis, project management, and contingencies.
- Construction costs consist of expenses for building construction, equipment purchase and installation, contractor overhead, design and inspection, construction management, project management, and contingencies. Mobilization and demobilization costs are included for portable treatment units.
- Operations and maintenance costs consist of expenses for annual operations labor and material; maintenance labor and equipment; utilities; contractor supervision and overhead; and related project management and contingencies.
- Decontamination and decommissioning costs consist of expenses for facility decontamination and demolition, closure, post-closure, and environmental monitoring activities.

8.14.2 PROCESS COSTS

DOE also analyzed costs based on treatment and storage. Treatment costs include costs to build and operate treatment facilities (such as thermal treatment) and common support facilities (such as maintenance, and certification/shipping facilities). DOE estimated costs for three treatment options: minimal treatment to current WIPP-WAC, an intermediate level of treatment to reduce gas generation potential, and treatment to meet LDRs. TRUW disposal is outside the WM PEIS scope; thus, life-cycle costs of disposal at WIPP were not included.

Table 8.14-1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts are Assessed	Location of Impacts Assessment
Process costs	Treatment	Life-cycle costs for treatment including support facilities and retrieval/characterization facilities	Table 8.14-2
	Storage	Life-cycle costs for storage facilities for one-year of treatment production was included, assuming a moderate delay from treatment to shipment to disposal	Table 8.14-2
Transportation cost	Truck	Inter-site common carrier costs for transportation from generating sites to treating sites, and to disposal sites	Table 8.14-2
	Rail	See above	Table 8.14-2

Note: No Action Alternative includes 20 years of storage and limited operations and maintenance.

For the purpose of the WM PEIS analysis, TRUW storage capacity for one year of treatment was included, assuming a moderate delay from the completion of treatment until the waste is transported for disposal.

Transportation costs include the costs associated with the physical movement of waste from one site to another, for treatment, storage, or disposal. Transportation costs are evaluated for both truck and rail shipments (INEL, 1995a).

A summary of costs is shown in Table 8.14-2 based on 20 years of treatment and storage (INEL, 1996). The total cost of treating to reduce gas generation is only slightly more (4%) than treating to WIPP-WAC. The total cost of treating to meet LDRs in a comparable regional configuration is approximately 22% more than treating to WIPP-WAC. As waste is consolidated at fewer sites, costs for treatment to meet LDRs decrease, illustrating the economy of scale of using larger and fewer facilities.

Under the No Action Alternative, DOE would treat only waste that required urgent repackaging to prevent leakage at the site. The No Action Alternative costs provide a baseline for comparison with the other alternatives. The relative proportion of truck transportation costs is small, varying from 0% to 8% of the total costs. Rail transportation costs vary from 0% to 20% of the total costs.

Table 8.14-2. Life-Cycle Costs (billions of 1994 dollars)

Alternative	Number of Sites: CH Treat	Number of Sites: RH Treat	Treat Standard	Total Costs[a] (including truck transportation)	Life-Cycle Costs: Pre-ops	Life-Cycle Costs: Const	Life-Cycle Costs: O&M	Life-Cycle Costs: D&D	Process Costs[b]: RC	Process Costs[b]: T	Process Costs[b]: S	Transportation Costs: Truck	Transportation Costs: Rail
No Action[c]	11	5	WIPP-WAC	1.7	0	0	1.47	0.24	0	1.48	0.23	0	0
Decentralized[d]	16	5	WIPP-WAC	7.4	0.4	1.72	3.40	1.35	2.15	4.42	0.31	0.56	1.44
Regionalized 1	5	2	Reduce gas	7.7	0.5	1.79	3.53	1.36	2.15	4.70	0.33	0.51	1.40
Regionalized 2	5	2	LDRs	9.0	0.6	2.42	4.13	1.38	2.15	6.09	0.29	0.45	1.24
Regionalized 3	3	2	LDRs	8.5	0.6	2.31	3.80	1.31	2.15	5.61	0.24	0.49	1.29
Centralized	WIPP	2	LDRs	7.9	0.5	2.21	3.49	1.18	2.15	5.17	0.06	0.51	1.33

Notes: Pre-ops = preoperations; Const = construction; O&M = operations and maintenance; D&D = decontamination and decommissioning; RC = retrieval and characterization; T = treatment; S = storage; CH = contact-handled; RH = remote-handled.

[a] Total Facility Costs are presented twice in this table: as life-cycle costs and as process costs. The sum of life-cycle costs is equal to the sum of process costs. In Total Costs, also in the table, truck transportation costs are added to the facility costs. Therefore, Total Costs equal the sum of life-cycle costs and truck transportation costs and also equal the sum of process costs and truck costs.

[b] The costs of current storage are included in the site infrastructure costs, which are not included in this PEIS. The cost of one-year's storage after treatment, but prior to shipment for disposal at WIPP, is included.

[c] For the No Action Alternative storage is indefinite, costs are only estimated for 20 years, and no disposal at WIPP is assumed. However, costs are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.

[d] In the Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to 10 sites for interim storage, and then sent to WIPP for disposal.

8.15 Environmental-Restoration-Transferred Waste

The total volume of TRUW generated by environmental restoration activities that would be transferred to the waste management program is currently estimated to be about 60% of the volume of waste management TRUW. Because the radiological and hazardous chemical profiles and physical characteristics of the environmental restoration (ER) transferred TRUW have not yet been determined to the extent necessary to allow a meaningful evaluation of the potential environmental and human health impacts, the potential effects resulting from the treatment of the ER transferred TRUW are discussed separately in the WM PEIS. When the radiological and physical characteristics of the ER transferred waste are better known, DOE may need to assess the impacts of managing the ER transferred TRUW on a site-specific basis.

DOE is responsible for the management of wastes currently in inventory and those generated by future operations (referred to as "waste management" wastes). As discussed in Chapter 1, DOE is also responsible for the management and remediation of contaminated media, such as soils, groundwater, and buildings. DOE expects that most of the contaminated media at its sites will be remediated under the Environmental Restoration Program. The extent to which media are "cleaned up" is site-specific and will depend largely on regulatory requirements and decisions regarding future land use. For analysis purposes, a standard "base case" scenario was developed that estimates remediation costs across the DOE complex (DOE, 1996c). Although most waste generated by cleanup activities will be managed within the Environmental Restoration Program, some of the waste generated by these activities will be transferred to waste management facilities. In the WM PEIS, these wastes are referred to as "environmental restoration (ER) transferred wastes." At present, only estimates of the volumes of ER transferred waste are available. These estimates were used to provide a qualitative assessment of how the addition of ER transferred waste might impact TRUW alternatives described in this chapter.

Appendix B provides more detail about how some of the wastes generated during environmental restoration activities will be transferred to the waste management program for final disposition, and provides estimates of the volumes of ER transferred TRUW. Appendix B also discusses the assumptions and uncertainties involved in assessing how the ER transferred TRUW may affect waste management alternatives.

To conduct a health risk impact analysis for the additional ER transferred TRUW similar to that conducted for waste management TRUW, additional information is needed on the ER transferred waste streams. In addition to the volume of ER transferred waste, information is needed on the treatability of the individual transferred TRU waste streams that would include data about the radiological profile, chemical constituents, and physical form of the transferred waste. Characterization of the ER transferred wastes into one of the treatment categories identified for TRUW is needed to estimate the degree of further treatment needed and, thereby, the waste management costs. Information about the timing of the transfer of ER wastes to the waste management program is needed to determine the capacities of treatment and disposal facilities. This information is also crucial to conduct transportation and socioeconomic analyses. However, in many cases, this information will not be available until site-specific cleanup is underway.

To identify how the addition of ER transferred TRUW could affect the comparisons among waste management alternatives evaluated in the WM PEIS, DOE compared the volumes of waste management TRUW with the expected volumes of ER transferred TRUW. This analysis reveals the potential for exceeding the capacity of treatment facilities of those sites and for those alternatives where the volume of ER transferred TRUW equals or exceeds the volume of waste management TRUW. Strategies that might be used to manage the additional ER transferred waste at these sites include increasing facility operational capacity and operating a facility longer to "work off" the increased waste load. The WM PEIS treatment facilities are assumed to have an effective operational life of at least 30 years, which allows for an additional 20 years of operational capacity beyond the 10 years needed to work off the waste management wastes.

Increased radiation and chemical exposure risks to site workers, offsite populations, and the environment are a function of the chemical constituents and radiological activity in the ER transferred wastes, which, at present, cannot be reliably predicted. However, because radiological activities and chemical concentrations of ER transferred waste are, in general, expected to be lower than those of comparable waste management waste, risks from the addition of ER transferred wastes are expected to be lower than those from the treatment of equivalent volumes of waste management wastes. Site-specific performance assessments would be conducted, and appropriate treatment restrictions would be imposed to manage any potential increased risks. The risks from physical hazards associated with operating treatment facilities to manage the ER transferred waste are related to the volume relationship between the ER transferred and waste management wastes. Transportation risks and costs are also dependent on waste volume rather than the composition of the waste.

Overall, the volume of ER transferred TRUW is expected to be about 60% of the waste management TRUW load (80,000 cubic meters compared with 132,000 cubic meters, respectively) (see Table B.6–1 in Appendix B). The additional ER transferred waste would affect waste treatment at SRS under the Decentralized and Regionalized Alternatives (see Table B.7-3). The additional ER transferred TRUW at SRS is expected to be 380% of the waste management load. The additional ER transferred TRUW would have little impact on the Centralized Alternative.

8.16 Comparison of Alternatives Summary

Health Risks. The most adverse health risks would occur under alternatives where TRUW is treated to meet LDRs—in Regionalized Alternatives 2 and 3 and the Centralized Alternative. These alternatives require the thermal treatment of organic TRUW, which would result in emissions of radionuclides (Pu-238 and Am-241) that have the most significant impact on offsite cancer risks. Although waste management worker fatalities would result primarily from physical trauma, fatalities are lower when TRUW is treated to meet WIPP-WAC or reduce gas generation than when it is treated to meet LDRs. Estimated transportation fatalities are low in all alternatives.

Air Quality Impacts. The management of TRUW would not affect the air quality at most sites; however, emissions of radionuclides were estimated to exceed the applicable standards at LANL and WIPP in the alternatives involving treatment to meet LDRs at these sites (Regionalized Alternative 2 at LANL and the Centralized Alternative at WIPP). The exceedances at these sites could require additional measures to reduce emissions to acceptable levels. Emissions of other hazardous air pollutants and criteria pollutants were estimated to be below the applicable standards at all sites.

Water, Ecological, Cultural, and Land Use Impacts. Major impacts to these resources at the sites are unlikely for treatment of TRUW under any of the alternatives. However, ecological and cultural impacts analysis would require that further site-specific studies be conducted before locations for specific facilities would be selected at sites.

Economic Impacts. Nationwide, the largest economic effects of TRUW management would occur under the Decentralized Alternative and would generally decrease as the alternatives become more centralized. The greatest benefit at any site occurs when TRUW is managed at that site. The greatest number of jobs attributable to management of TRUW, as a percentage of the regional baseline, would occur at INEL and WIPP under Regionalized Alternative 3 and the Centralized Alternative, respectively. None of the TRUW alternatives would substantially affect the national economy, although some 1,900 to 12,000 jobs would be directly or indirectly created.

Population Impacts. No major population increases are expected to occur at any site under any alternatives and thus, community characteristics and the provision of services would not be affected.

Environmental Justice Concerns. Assessment of potential environmental justice concerns associated with TRUW management indicated a potential for disproportionately high and adverse health risks or environmental impacts to minority and low-income groups at the INEL and WIPP sites. This potential would be mitigated by selection of an alternative treatment technology, employment of more efficient emissions controls, and other measures.

Infrastructure Impacts. Infrastructure impacts on water use, wastewater treatment, and power are comparable for the Decentralized and Regionalized Alternatives but are much greater at WIPP under the Centralized Alternative.

Costs. Costs increase as the level of treatment increases. Treatment to WIPP-WAC and treatment to reduce gas generation potential cost approximately the same in nondiscounted 1994 dollars. Treatment to meet LDRs costs approximately 22% more in nondiscounted 1994 dollars. Transportation costs are lower than facility costs, making shipment to available facilities at another site generally less expensive than building a new facility when one does not exist at a site. The details of cost estimating are covered in Section 5.3.3 of Chapter 5.

Summary of Impacts by Alternative. Table 8.16–1 summarizes the impacts of each alternative.

The Preferred Alternative. Most of the Department's sites with TRUW would treat and store it onsite. Five sites would ship TRUW to other sites for treatment under the preferred alternative: Pantex would ship its de minimis inventory of TRUW to LANL; RFETS would ship some of its TRUW to INEL for treatment; ORR would send its CH-TRUW to SRS for treatment; SRS would send its RH-TRUW to ORR for treatment; and SNL-NM would send its TRUW to LANL for treatment. This preference assumes that the Waste Isolation Pilot Plant (WIPP) will require treatment to the waste acceptance criteria the Department has proposed to the Environmental Protection Agency for this geologic repository. The Department's preference could change if WIPP requires a different level of treatment. The Department would store its TRUW where it is treated pending a decision on its disposal or other disposition.

DOE's preferred alternative is a combination of parts of the Decentralized Alternative and several of the Regionalized Alternatives as shown in Table 3.7–1. It provides for cost-effective management of TRUW, poses low potential risks to the public, and has relatively small environmental impacts. DOE's preference is consistent with the preferred alternative identified in the Draft Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement (WIPP SEIS II) (DOE, 1996e).

Table 8.16–2 provides potential impacts for the preferred alternative by combining the impacts evaluated in the WM PEIS for the preferred alternative at each site. Treatment and storage impacts are taken from Volume II site data tables for the preferred alternative specified in the second row of Table 8.16–2.

Table 8.16–1. Comparison of TRUW Alternatives—Selected Impacts

Alternative	Number of Sites: CH Treat	Number of Sites: RH Treat	Treatment Standard	Treatment Worker Physical Hazard Fatalities	Treatment Worker Cancer Fatalities	Offsite Population Cancer Fatalities	Truck Radiation Fatalities	Truck Non-Radiation Fatalities	Number of Sites With Air Pollutants That Exceed Standards	Highest Air Pollutant Percentages at Any Site	Truck Shipments	Cost ($ Billions)	Comment
No Action[a]	11	5	WIPP-WAC	*	*	*	0	0	0	8 (CO-RFETS)	0	1.7	Extended Storage not in compliance with RCRA
Decentralized[b]	16	5	WIPP-WAC	2	1	*	4	3	0	49 (NO_2-ANL-E)	24,000	7.4	10 sites provide interim storage, then ship to WIPP
Regionalized 1	5	2	Reduce gas	3	1	*	3	3	0	40 (NO_2-ANL-E)	22,000	7.7	4 western, 2 eastern sites shred and grout to reduce gas generation
Regionalized 2	5	2	LDRs	4	1	1	3	2	1	134 (Rad-LANL)	19,000	9.0	4 western, 2 eastern sites treat to meet LDRs
Regionalized 3	3	2	LDRs	3	1	*	3	3	0	34 (NO_2-ANL-E)	21,000	8.5	2 western, 2 eastern sites treat to meet LDRs
Centralized 5	WIPP	2	LDRs	2	1	*	3	3	1	137 (Rad-WIPP)	22,000	7.9	WIPP + 1 eastern, 1 western site treat to meet LDRs

CH = contact handled TRUW; RH = remote handled TRUW; LDRs= Land Disposal Restrictions; WIPP-WAC = Waste Isolation Pilot Plant-Waste Acceptance Criteria; * = greater than 0 but less than 0.5.

[a] For No Action Alternative, storage is indefinite, no disposal at Waste Isolation Pilot Plant is assumed; however, risks are provided for only the first 20 years of indefinite storage (see Section 8.3.1). For all other alternatives, disposal at WIPP is assumed.

[b] In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table 8.16–2. The Preferred TRUW Alternative—Selected Impacts

Impact Area	Decision	ANL	Hanford	INEL[c]	LLNL	LANL	NTS	ORR	Pantex	PGDP	RFETS	SNL-NM[d]	SRS	WIPP	WVDP[d]	Total
Preferred alternative	T	D	D	R3	D	D	D	R1	*[e]	D	D	R1	R1	D	D	
Worker physical hazard fatalities	T	1.2E-01	2.6E-01	1.8E+00	1.1E-01	3.8E-01	6.8E-02	1.0E-01	--	1.3E-02	2.1E-01	--	1.5E-01	--	--	3.2E+00
Worker cancer fatalities	T	8.8E-03	1.3E-01	2.5E-01	5.6E-04	1.4E-01	2.1E-04	2.8E-03	--	4.6E-07	7.7E-03	--	7.7E-02	--	--	6.2E-01
Offsite population cancer fatalities	T	2.0E-06	2.3E-05	4.1E-02	3.5E-06	5.4E-05	1.1E-10	8.3E-07	--	3.5E-09	9.3E-06	--	1.4E-04	--	--	4.1E-02
Truck radiation fatalities		These numbers reflect intersite transportation results and are not attributable to individual sites.														≤4
Truck nonradiation fatalities																≤3
Highest air pollutant percentage		49% NO_2	2% NO_2	17% PM_{10}	0%	1% NO_2	6% CO	0%	--	1% NO_2	19% CO	--	1% NO_2/PM_{10}	--	--	No sites exceed
Cost (10^9 \$)[a]		0.33	1.81	2.49	0.23	0.92	0.096	0.48	--	0.05	0.38	--	0.86	--	--	7.65
Truck shipments[b]		590	10,260	7,610	260	1,590	90	2,440	--	10	830	10	1,240	23,860	--	48,790

[a] Cost for truck transportation (estimated at \$0.6 billion) were added to these site totals for a total alternative cost of \$8.2 billion.
[b] Shipments include inbound shipments to INEL (2,060), ORR (390), and SRS (160). Total one-way shipments between two sites, as defined for shipment totals in Table 8.16-1, are 48,790 ÷ 2 = 24,395 shipments.
[c] Includes impacts of onsite treatment of RH-TRUW to meet current WIPP-WAC.
[d] SNL-NM and WVDP are included because they are major sites that would manage TRUW onsite under the Regionalized 1 and Decentralized Alternatives, respectively, noted here as the Preferred Alternatives at those sites. However, health risks and environmental impacts were not evaluated at SNL-NM and WVDP; they are expected to be minimal because the TRUW volumes are very small (less than 2 cubic meters).
[e] The current DOE plan is to ship the very small amount of CH-TRUW at Pantex to LANL for treatment and storage.

Chapter 8
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Transuranic Waste Alternatives

Alt.	CH Treat	RH Treat	Treat Stand	ANL-E	Hanford	INEL	LANL	LLNL	NTS	ORR	PGDP	RFETS	SNL-NM[d]	SRS	WIPP	WVDP[d]
No Action	11	5	WIPP WAC	TS	TS	TS	TS	TS	S	TS	S	TS	S	TS		S
D	16	5	WIPP-WAC	TS	TS	TS	TS	TS	TS	TS	T	TS	T	TS		T
R-1	5	2	Reduced gas		TS[a]	TS	TS			TS[b]		TS		TS		
R-2	5	2	LDRs		TS[a]	TS	TS			TS[b]		TS		TS		
R-3	3	2	LDRs		TS[a]	TS				TS[b]				TS		
C	WIPP	2	LDRs		TS[c]					TS[b]					T	

Notes: T = treatment to one of three standards: process to current WIPP-WAC; shred and grout to reduce potential for gas generation in the repository (Reduced gas); and treat to meet LDRs using thermal organic destruction and complete treatment train. S = storage after treatment for one year, prior to transport for disposal, for all alternatives except No Action or store current inventory under No Action Alternative. Blanks indicate that TRUW is not treated or stored at a site under the specified alternative.

[a] The Hanford Site treats both CH and RH waste.

[b] ORR treats RH waste only.

[c] The Hanford Site treats RH waste only.

[d] SNL-NM and WVDP are included because they are major sites that would manage TRUW onsite under the Regionalized 1 and Decentralized Alternatives, respectively; noted here as the preferred alternatives at those sites. However, health risks and environmental impacts were not evaluated at SNL-NM and WVDP; they are expected to be minimal because the TRUW volumes are very small (less than 2 cubic meters).

CHAPTER 9
Impacts of the Management of High-Level Waste

Chapter 9 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for storing vitrified high-level waste (HLW). This chapter provides information on existing HLW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to HLW characteristics and the rationale for selecting the sites analyzed under each alternative. The chapter discusses the health risk, environmental impacts, and costs of the alternatives, and provides a comparison of alternatives.

The methods used to evaluate the impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the HLW analysis are contained in the technical report entitled "High-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports provided in Chapter 15.

9.1 Background

9.1.1 DEFINITION AND ORIGIN

The term HLW means (a) the highly radioactive waste material that results from the reprocessing of spent nuclear fuel (SNF), including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation, and (b) other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

- *HLW is highly radioactive waste material that results from the reprocessing of spent nuclear fuel and irradiated targets in nuclear defense, research, and production activities.*
- *The WM PEIS only analyzes the impacts of stored vitrified HLW.*
- *HLW has both radioactive and hazardous components and is considered mixed waste.*
- *HLW will be treated and packaged for disposal in a licensed geologic repository.*
- *HLW is currently stored at the Hanford Site, the Idaho National Engineering Laboratory (INEL), the Savannah River Site (SRS), and the West Valley Demonstration Project (WVDP).*
- *Approximately 378,000 cubic meters of HLW have been or will be generated. Treated (vitrified) HLW will require an estimated 21,600 canisters for packaging.*
- *DOE must decide where to store the vitrified HLW canisters.*

HLW also contains toxic metal, organic materials, or corrosive characteristics that are considered hazardous under the Resource Conservation and Recovery Act (RCRA) (42 USC 6901). Because it is both radioactive and hazardous, HLW is considered mixed waste.

The WM PEIS analyzes only the impacts of stored vitrified HLW. DOE must decide where to store vitrified HLW canisters since the decision to immobilize the HLW prior to transport was made in the early 1980s. Just prior to the passage of the Nuclear Waste Policy Act (NWPA) in 1983, Congress directed the President to prepare a report that would describe plans for permanent disposal of HLW and TRUW resulting from atomic energy defense activities. The President's report (*The Defense Waste Management Plan*, DOE/DP-0015) was submitted to Congress in June 1983. The report describes reference plans for the immobilization of HLW resulting from defense activities at SRS, INEL, and Hanford. (The HLW at WVDP from commercial spent nuclear fuel reprocessing was not addressed in this report, but the West Valley Demonstration Project Act [Public Law 96-368] requires that DOE take similar actions with regard to West Valley's HLW.)

The goal of the HLW management was to end interim storage and to achieve permanent disposal by immobilizing and preparing HLW for shipment to a geologic repository. Each HLW site has taken steps to follow the President's plan regarding immobilizing HLW in a sequential manner. This approach is intended to permit the applicable operating experience gained at the first site to be applied to the other sites, thereby resulting in a more efficient use of resources, including funding.

The Nuclear Waste Policy Act (42 USC 10101–10270) enunciated the national policy that HLW be solidified and disposed of in a mined geologic repository. The U.S. Nuclear Regulatory Commission (NRC) has established requirements for the performance of a geologic repository. DOE must submit an application for a repository license and show that the mined geologic disposal system, including repository site natural barriers, engineered barriers, waste packages, and shaft seals will meet NRC requirements. The U.S. Environmental Protection Agency (EPA) will promulgate public health and safety standards for protection of the public from releases of radioactive materials disposed of in a candidate geologic repository as required by the Nuclear Waste Policy Act and the Energy Policy Act (42 USC 10101–10270).

For purposes of the WM PEIS, a geologic repository candidate site at Yucca Mountain, Nevada, was assumed to be the final disposal site for all HLW. Currently, Yucca Mountain is the only site being characterized as a geologic repository for HLW. If selected as the site for development, it would be ready to accept HLW no sooner than 2015. The potential environmental impacts at a geologic repository from the disposal of HLW are not yet known and therefore not addressed in the WM PEIS. DOE is preparing another EIS to analyze site-specific environmental impacts from construction, operation, and eventual closure of a potential geologic repository for spent nuclear fuel (SNF) and HLW at Yucca Mountain.

9.1.2 VOLUMES AND LOCATIONS

Government operations from 1944 to the present have generated about 357,000 cubic meters (94 million gallons) of HLW, with approximately 21,000 cubic meters (5.6 million gallons) to be generated within the next 20 years (DOE, 1995e, 1996b). Only four sites either store or manage HLW: the Hanford Site, INEL, SRS, and WVDP. There is a discussion in Section 9.2.3 of the potential additional HLW canisters that may be generated if the Department proposes to chemically process SNF in the future, and a discussion of their potential impacts is in Section 9.4.4.

DOE is proceeding with plans to treat HLW by processing it into a glass form that would not be readily dispersible into air or leachable into ground or surface water. This process is called vitrification. If the existing inventory of HLW is vitrified, the vitrified material will fill an estimated 21,600 canisters. Canisters are assumed to vary in volume of vitrified HLW between 0.62 and 1.17 cubic meters.

Table 9.1–1 shows the projected HLW inventory at the Hanford Site, INEL, SRS, and WVDP; and the projected total vitrified HLW canisters that will be produced as a result of treating the entire HLW inventory.

Table 9.1–1. High-Level Waste Volumes and Projected Number of Estimated HLW Canisters

Site	HLW Volume (m^3)	Total Number of Estimated Canisters to Be Produced
Hanford	213,000	15,000
INEL	10,400	1,700
SRS	152,000	4,572
WVDP	2,200	340
Total	378,000	21,600

Sources: ANL (1996); DOE (1994a; 1995b, d-f; 1996a-c); WINCO (1994).

The estimated number of HLW canisters to be produced at each site shown in Table 9.1–1 is dependent on waste characteristics, volume prior to treatment, final waste loading and immobilized form, and canister size. These factors vary from site to site and result in a nonlinear relationship between the projected number of HLW canisters and the initial waste volume.

The WM PEIS analyses for SRS are based on a total HLW inventory of 4,572 canisters (DOE, 1994a, 1995d). The latest version of the *High-Level Waste System Plan* (1996) projects a total of approximately 6,000 canisters to be produced at SRS. Preliminary analysis indicates that the impacts associated with the higher total number of canisters (6,000) are similar to those for the canister inventory applied in the WM PEIS (4,572). The WM PEIS forecasts conservative results because although the number of canisters applied in the WM PEIS analyses is lower than the number projected in the *High-Level Waste System Plan* (WSRC, 1995), an individual canister has a greater radiological activity when compared with that in the *High-Level Waste System Plan*; thus, an accident associated with this canister would have greater impacts (as an example). Similarly, the occupational dose received by the workforce during interim storage of HLW canisters pending disposal at a national geologic repository appears to be greater when the WM PEIS canister inventory is used, again because of the higher radiological activity of a single canister. The overall risk of transportation would increase on the average by 11% and at most by 14% for the Centralized Alternative, Case 2, when the higher SRS canister number is used. The uncertainty in the total number of canisters at Savannah River does not significantly affect decisions made within the WM PEIS concerning HLW management.

The Hanford Tank Waste Remediation System EIS (DOE, 1996b) presents a total of approximately 12,200 canisters projected to be produced at Hanford. The WM PEIS analyses for the Hanford Site are based on a total HLW canister inventory of 15,000 canisters. Preliminary analysis indicates that the impacts associated with the lower total number of canisters (i.e., 12,200) are similar to those for the canister inventory applied in the WM PEIS (i.e., 15,000). The WM PEIS forecasts conservative results because the number of canisters applied in the WM PEIS analyses is greater than that in the Tank Waste Remediation System EIS (DOE 1996b), and an individual canister has a greater radiological activity (by approximately 50%) compared with the TWRS EIS. Thus, an accident associated with this canister would have greater impacts, and as an example, the occupational dose received by the workforce during interim storage of HLW canisters pending disposal at a national geologic repository appears to be greater using the WM PEIS canister inventory, again due to the higher radiological activity of a single canister. The overall risk of transportation would decrease on the average by 10% and at most by 12% for the No Action Alternative using the lower Hanford canister number. In general, the final number of canisters at Hanford would depend on the decisions based on the TWRS EIS and performance of separations and treatment processes implemented to treat the HLW. The uncertainty in the total number of canisters at Hanford does not significantly affect decisions made within the WM PEIS concerning HLW management.

Changing the number of canisters at INEL results in comparatively more impacts. As an example, the transportation risk would increase on the average by 20% and at most by 36% for the Centralized Alternative, Case 2. The number of storage facilities would decrease from a total of four for the 8,500-canister total used in the Draft WM PEIS to one for the updated value of 1,700 canisters, with a resulting fourfold decrease in the facility construction and operations impacts. In this case, revision of the number of canisters at INEL could affect decisions made within the WM PEIS concerning HLW management, and it would appear reasonable to consider the more recent HLW canister totals for INEL. For this reason, the Final WM PEIS uses the more current estimate of canisters for INEL.

9.1.2.1 Hanford

HLW has been generated at the Hanford Site as a result of plutonium production, research and development for advanced reactors, renewable energy technologies, waste disposal technologies, and cleanup of contamination from past practices. The Hanford Site began storing liquid HLW in belowground tanks in 1944. Over the years, three substantially different separations processes have been used at the site. In all cases, the acidic wastes were neutralized for storage in carbon steel tanks. Further, in order to remove strontium and cesium from the less active materials at the Hanford Site, several precipitation procedures were employed. These resulted in the concentration of strontium and cesium, now stored in metal, double-walled capsules with an external diameter of approximately 6.7 cm (2.6 in.) and an overall length of about 53 cm (21 in.), and in the introduction of organic and ferrocyanide precipitating agents which have produced potentially dangerous conditions in some of the tanks.

In April 1988, the Hanford Defense Waste EIS Record of Decision was published in the *Federal Register* (53 FR 12449). However, important changes have occurred since the 1988 decision. The Tank Waste Remediation System Final EIS (DOE, 1996b), issued in August 1996, addresses actions to manage and dispose of approximately 213,000 cubic meters (56 million gallons) of radioactive, hazardous, and mixed waste within the Tank Waste Remediation System program at the Hanford Site (61 FR 45949). The EIS also addresses actions to manage and dispose of the cesium and strontium contained in approximately 1,930 metal, double-walled capsules. The EIS identifies Phased Implementation as the preferred alternative for remediating Hanford's high-level tank waste. (The preferred alternative for the cesium and strontium capsules is to continue storage.) Under the Phased Implementation Alternative, the high-level tank waste would be remediated in a two-phase process. Phase 1 would involve design, construction, and operation of demonstration-scale treatment facilities. Phase 2 would be implemented following Phase 1 and would involve the design, construction, and operation of full-scale treatment facilities to remediate the remainder of the tank waste. Under both phases of the preferred alternative, the HLW would be vitrified and placed into canisters for interim storage pending offsite disposal at a geologic repository.

The tank waste is mainly in three forms — liquid, saltcake, and sludge — and is contained in 177 underground storage tanks (149 single-shell and 28 double-shell tanks) built between 1943 and 1986. Vitrification of all Hanford HLW is expected to be completed by the year 2028.

The estimated number of HLW canisters to be produced from vitrification of the Hanford Site tank waste depends on the performance of separations and treatment processes implemented to treat the HLW. For purposes of the WM PEIS, an estimated 15,000 canisters were assumed to be produced from treating existing HLW (Walters, 1995).

9.1.2.2 INEL

INEL's anticipated generation and management activities will result in approximately 7,600 cubic meters (2 million gallons) of liquid HLW and 3,800 cubic meters (1 million gallons) of calcined HLW in storage at the Idaho Chemical Processing Plant. Liquid HLW has been blended routinely with sodium-bearing liquid and calcinated at the New Waste Calcining Facility, which converts the waste into dry, noncorrosive granules. The calcinated waste is stored in stainless steel closed bins inside near-surface concrete vaults (DOE, 1995b).

Calcination of liquid HLW at INEL results in a solid that is safer to store than liquid waste but does not meet NRC requirements for disposal in a repository. The calcination process may be classified as an interim best demonstrated available technology by EPA under RCRA, pending development of a process to produce a stable glass, ceramic or glass/ceramic that will meet both Atomic Energy Act and RCRA requirements. Characteristics of INEL waste suggest the waste form will be a borosilicate glass material.

INEL built the New Waste Calcining Facility to convert the liquid HLW at the INEL into dry, noncorrosive granules that are stored in stainless steel, closed bins inside near-surface concrete vaults. The Final Programmatic Spent Nuclear Fuel and INEL Environmental Restoration and Waste Management Programs EIS (DOE, 1995b) analyzed a Waste Immobilization Facility (WIF) Project to immobilize the Idaho Chemical Processing Plant radioactive wastes (sodium-bearing liquid and solid calcine) into forms suitable for permanent disposal. The SNF and INEL EIS, Volume 2, Part B, Section C.4.3.2, presents a project description for calcine treatment technology development. No decision has been made on the construction of the WIF, and no decision has yet been made on whether further treatment of the calcinated waste will occur before shipment to a geologic repository. The WM PEIS assumes that production of HLW canisters will begin in 2015 and be completed in 2035 (DOE, 1995d). An estimated 1,700 HLW canisters will be produced.

9.1.2.3 SRS

An inventory of approximately 131,000 cubic meters (34 million gallons) of HLW is stored in belowground tanks in the F- and H-Areas near the center of SRS. This waste was generated as a result of defense, research, and medical programs. Approximately 22,000 cubic meters (5.8 million gallons) are projected to be generated within the next 20 years.

SRS completed the Defense Waste Processing Facility (DWPF) Supplemental EIS in November 1994 (DOE, 1994a). The DWPF includes the HLW pretreatment process, the Vitrification Facility, saltstone manufacturing and disposal (LLW resulting from the pretreatment of HLW), radioactive glass waste storage facilities, and associated support facilities. The Record of Decision (March 28, 1995) describes the Department's decision to complete construction and begin operation of the DWPF. The DWPF became operational on March 12, 1996. Vitrified HLW canister production began in 1996 and is to be completed in 2020 (DOE, 1994a). For purposes of this EIS, the estimated total number of canisters is assumed to be 4,572, the total planned storage capacity of HLW canisters at SRS (DOE, 1995a).

9.1.2.4 WVDP

The WVDP is being conducted at the Western New York Nuclear Services Center near West Valley, New York. It is owned by the New York State Energy Research and Development Authority. Commercial operations generated HLW from reprocessing spent nuclear fuel at WVDP from 1966 to 1972. Under the West Valley Demonstration Project Act (42 USC 2021a *et seq.*), DOE is demonstrating the solidification for disposal of liquid HLW.

The WVDP HLW inventory is approximately 2,200 cubic meters (580,000 gallons). All the HLW will be blended together with glass-forming materials and vitrified into a borosilicate glass waste form. DOE and the New York State Energy Research and Development Authority (NYSERDA) completed a Final Environmental Impact Statement, *Long Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley* (DOE, 1982). The Record of Decision, issued in September 1982, identified that the liquid HLW would be vitrified and transported to a geologic repository for disposal. Vitrification at the WVDP began on July 2, 1996. Vitrification should result in the production of an estimated 340 canisters (ANL, 1996).

Analysis in the WM PEIS assumes use of existing storage facilities until their capacities are met. If additional capacity is needed, use of new conceptual facilities is assumed. These conceptual facilities provide the difference in storage capacity between existing storage capacity and what is necessary to manage the waste received under any given alternative. Conceptual facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). When necessary for analysis, an assumption was made that the impact of existing facilities essentially reflects the impact of conceptual facilities.

9.1.3 Existing and Planned Facilities Available at DOE Sites

Each alternative considered in this PEIS for storage of HLW canisters involves three major facilities and features: the HLW canisters, the facilities for the storage of HLW canisters, and the packages for transporting HLW canisters. The following sections briefly describe each of these facilities and features.

9.1.3.1 High-Level Waste Canisters

HLW canisters are large stainless steel cylinders resembling those typically used to store gases (such as oxygen). In the vitrification process, a molten mixture of HLW and glass-forming materials is poured into the canisters. After each canister is filled, it is sealed with a welded plug. After sealing, each canister is tested for leaks and the surface is decontaminated. Following decontamination, the canisters are loaded into a shielded cask and transferred to storage. Table 9.1–2 lists the dimensions, weights, and activity levels of the HLW canisters assumed in this PEIS at the four HLW sites.

9.1.3.2 Storage Facilities for High-Level Waste Canisters

Storage facilities for HLW canisters are buildings containing underground plugged storage vaults within a concrete structure that is designed to withstand earthquakes and other natural disasters. When casks containing HLW canisters are received at a storage facility, the HLW canisters are unloaded. A concrete plug is lifted from the top of the storage vault, or from the floor of the building, and the canisters are lowered into tubes within the cavity. Each storage tube, or sleeve, is then sealed to prevent the canisters from coming into direct contact with cooling or ventilation system air. After the storage tubes are sealed, a concrete plug is lowered over the cavity. Radioactive decay heat from the canisters is transferred to the

Table 9.1–2. Dimensions, Weights, and Activity Content of HLW Canisters

Characteristics	Hanford	INEL	SRS	WVDP
Material	Stainless steel			
Outer diameter (cm)	61	N/A	61	61
Overall height (cm)	300	N/A	300	300
Nominal wall thickness (cm)	0.95	N/A	0.95	0.34
Total weight (kg)	2,150	N/A	2,182	2,152
Activity per canister (curies)	1,373	9,000	2,344	1,043
Decay heat per canister (watts)	389	26	709	311

Notes: The canister dimensions are assumed for this PEIS. Selection of a different size canister could result in a decrease or increase in the number of canisters produced and rate of acceptance at the repository.

Source: ANL (1996).

tubes and removed by a cooling or ventilation system. Although no radioactive emissions are expected during normal operation, a high-efficiency particulate air (HEPA) filtration system would be used to ensure minimal release of radioactivity to the atmosphere in the event a release occurred. Storage facilities for HLW canisters currently exist at SRS and WVDP. Storage facilities are planned for the Hanford Site and INEL.

The Glass Waste Storage Building at SRS has an estimated capacity of 2,286 canisters. The storage vault is designed as an earthquake- and tornado-resistant concrete structure. Radiation shielding protection for Glass Waste Storage Building workers is provided by concrete walls, earth embedment, and a concrete deck that forms the floor of the building and operating area. The building's forced air exhaust system would remove radioactive decay heat. The exhaust air would pass through the building's HEPA filter ventilation system and then be discharged into the atmosphere through the stack. No condensate is expected to accumulate in the ventilation system sump; however, if any does, it would be drummed, monitored for activity, and treated. Depending on activity levels, the condensate would be sent to the F- and H-Area Effluent Treatment Facility or incorporated into the Vitrification Facility wastewater stream for recycling to the SRS HLW tank farm. Although no activity is expected to occur in the condensate or exhaust air, provisions have been made for its management if activity is detected (DOE, 1994a). The construction of a second Glass Waste Storage Building has been approved in the Record of Decision for the Final Supplemental EIS for Defense Waste Processing Facility (DOE, 1995a). Upon completion of this building, total estimated storage capacity at SRS will be 4,572 canisters.

At WVDP, storage racks holding four canisters each would be used to transport HLW canisters to the Waste Canister Storage Facility, located in the existing Chemical Process Cell building which has been decontaminated and modified for storage of HLW canisters. The racks containing the HLW canisters would be stored on two levels to allow for a failed equipment storage area. The canister storage area would be equipped with two coolers to remove heat generated by the HLW canisters. Storage capacity is available for approximately 344 canisters (ANL, 1996).

DOE approved, as part of a previous EIS for the Hanford Site (DOE, 1987), a storage facility that would provide enough storage capacity for approximately 750 HLW canisters. It was assumed in the WM PEIS that the HLW canister storage facility would be operational by 2009.

9.1.3.3 Transportation Packages for High-Level Waste

Transportation of all DOE radioactive material must conform to the Hazardous Materials Transportation Act, Department of Transportation (DOT), and NRC regulations. HLW canisters would be transported in Type B packages, which provide a high degree of assurance that, even in severe accidents, package integrity will be maintained with essentially no loss of radioactive contents or serious impairment of the shielding capability provided by the package. DOE has prepared initial designs for a HLW waste cask for truck transportation based on SRS canister designs. As designed, the HLW waste cask uses a solid body concept to absorb energy during an accident and normal transportation. To minimize the exposure to gamma radiation, shielding would be provided by a depleted uranium liner inside the cask body. The WM PEIS assumed that the HLW truck cask would contain only a single HLW canister; however, it is likely that DOE will develop a multiple-canister truck cask, as well as a cask for transporting HLW canisters by rail. The WM PEIS assumed that five HLW canisters would be shipped per rail cask; therefore, rail transportation could reduce the number of shipments by at least 80%. Further details of the WM PEIS assumptions for transporting HLW canisters are contained in Appendix E. Currently, no casks for shipping HLW canisters by truck or rail have been certified by the NRC (ANL, 1996).

9.2 Analytical Methods and Assumptions

Reported HLW volumes, characteristics, and facilities were used to analyze human health risks, environmental and socioeconomic impacts, and costs associated with each of the HLW alternatives. To facilitate the analysis, DOE made numerous assumptions on HLW characteristics, facilities, and transportation. These assumptions are described below.

9.2.1 Characteristics

High-level waste is generated by the chemical reprocessing of SNF and irradiated targets generated in DOE programs for research, development, testing, and production, and from Naval propulsion fuel. The radioactivity from HLW results primarily from radionuclides of cesium, and strontium; a very small amount results from the decay of transuranic radionuclides. HLW also contains toxic metals and organic materials that are considered hazardous under RCRA.

High-level waste may be found in a number of forms: acidic liquid, caustic liquid with or without sludge, saltcake, slurry, or dry granular calcine. As generated, HLW is a highly acidic liquid solution and must be handled and stored in corrosion resistant vessels, generally stainless steel. During World War II, because of a shortage of stainless steel, HLW was neutralized so it could be stored in carbon steel tanks. Treatment of HLW with excess caustic precipitated fission product metal oxides and hydroxides which collected as sludge on the tank floor. Often, high heat from fission product decay caused evaporation of significant amounts of water, leading to a viscous solution with elevated salt content and crystallized salts, commonly referred to as "saltcake." Although SRS and WVDP have neutralized their HLW, the INEL reprocessing plant kept its HLW acidic and stored it in stainless steel tanks pending pretreatment to a granular solid through a process called "calcination." This "calcine" is stored for future processing to a final waste form. Vitrification into a glass form, after radionuclide partitioning, has been chosen for testing for potential use in immobilizing the high-level liquid and calcine waste at the INEL (DOE, 1995c).

Most nuclear radiation from HLW, after several years of initial decay, comes from the fission product radionuclides cesium-137 and strontium-90 (each with a half-life of approximately 30 years) and small amounts of transuranic radionuclides such as plutonium and americium (half-lives of thousands to millions of years). In alkaline solution, cesium remains in solution but strontium and the transuranic metals are found almost entirely in the sludge as insoluble oxides. The primary health risk from HLW arises from the intense radiation, not from chemicals. No matter what the physical form, HLW must be stored behind heavy shielding and handled using remotely operable equipment.

9.2.2 FACILITIES

Treatment. All four HLW sites are in some stage of planning or constructing facilities to treat HLW into an acceptable waste form for repository disposal. The existing and planned treatment facilities are described in Section 9.1.3.

Storage. For purposes of this PEIS, DOE assumed that storage facilities would be based on a modular design. The Glass Waste Storage Building for SRS was assumed to be the model for future storage facilities. Anticipated capacity for each module is assumed to be 2,286 canisters. DOE also assumed that it would take approximately three years to construct each module. Based on the total estimated number of canisters to be produced, 12 storage modules would need to be constructed system wide. One module currently exists at SRS and full storage capacity for the WVDP canisters exists at that site.

Disposal. Under the Nuclear Waste Policy Act, HLW is planned to be disposed of at a geologic repository; Yucca Mountain in Nevada is the site currently being studied for suitability to house a geologic repository. The DOE assumes that acceptance of DOE-managed HLW at this facility will begin in 2015. In accordance with the repository program, DOE's annual limit for disposal is 400 metric tons uranium (MTU) equivalent (DOE, 1994c). The WM PEIS assumed that one (1) canister equals 0.5 MTU. Therefore, only 800 canisters per year can be shipped to a geologic repository based on this disposal rate. However, due to the rate at which canisters will be accepted at a geologic repository, storage capacity will have to be constructed for the total number of canisters produced, or production of the canisters will have to be paced to the openings of a geologic repository. Further, although a geologic repository for the permanent disposal of HLW is scheduled to begin accepting DOE-managed HLW in 2015, for purposes of analysis in the WM PEIS, DOE has also analyzed HLW canister storage requirements should the opening of a geologic repository occur some time after 2015.

9.2.3 Canister Production Rates

For purposes of the WM PEIS, the following assumptions were made regarding the production of canisters at each of the four HLW sites:

Hanford[1]

- The No Action Alternative assumes a production rate of 320 canisters per year, based on the Hanford Site EIS (DOE, 1987). The more recent TWRS EIS (DOE, 1996d) indicates an average annual production rate of about 450 canisters per year. All other WM PEIS alternatives assume an average annual production rate of 790 canisters per year.
- Canister production would begin in 2009 and would be completed in 2028.
- The Hanford Site would produce an estimated 15,000 canisters.

[1] The Department's Storage and Disposition PEIS evaluates a "can-in-canister" alternative for the disposition of plutonium in an immobilized form, where small cans of plutonium would be imbedded into larger canisters of vitrified HLW. This alternative could result in the production of a small number of additional canisters at one of these two sites because some of the vitrified HLW would be displaced by the smaller cans of immobilized plutonium. The small number of additional HLW canisters would not affect the conclusions reached in the WM PEIS.

INEL

- An average annual production rate of about 81 canisters per year is assumed for all alternatives, except the No Action Alternative. The No Action Alternative assumes no canister production because INEL does not have existing or planned HLW canister storage facilities and is not authorized for treatment to a final waste form acceptable for disposal in a candidate repository.
- Canister production would begin in 2015, and all HLW would be treated so that it is ready to be moved out of Idaho by a target date of 2035 consistent with the Court's order in the case of Public Service Company of Colorado v. Philip E. Batt Civil No. 91-0054-S-EJL (District of Idaho, Oct. 17, 1995).
- INEL would produce an estimated 1,700 canisters.

SRS[1]

- An annual average production rate of 190 canisters per year is assumed for all alternatives. The *High-Level Waste System Plan* (WSRC, 1995) indicates a maximum production rate of about 300 canisters per year.
- Canister production began in 1996 and will be completed in 2020.
- SRS would produce an estimated 4,572 canisters.

WVDP

- A production rate of approximately 100 canisters per year is assumed for all alternatives.
- Canister production began in 1996 and will be completed in 1998.
- WVDP would produce an estimated 340 canisters, based on the assumption that any retrieved spent fuel fines would be considered residues and handled in a manner consistent with HLW (DOE, 1996a).

Table 9.2–1 provides a summary of anticipated production rates for the No Action Alternative and all other alternatives.

Additional Canisters Generated From Foreign Research Reactor Spent Nuclear Fuel. Additional canisters of HLW could be generated from foreign research reactor SNF and other sources if chemical processing were applied to these materials (DOE, 1996b). These additional canisters could add to the inventory of canisters evaluated in the WM PEIS. It is estimated that up to 200 canisters could be produced at SRS in addition to the 4,572 canisters assumed in the WM PEIS, or alternatively, 300 canisters could

Table 9.2–1. High-Level Waste Canister Production Schedule for the No Action Alternative and All Other Alternatives

Action	Site			
	Hanford	INEL	SRS[a]	WVDP
High-Level Waste Canister Production for the No Action Alternative[b]				
Anticipated start of production	2009	0	1996	1996
Anticipated end of production	2028	0	2020	1998
Anticipated start of shipping to repository	2016	0	2037	2016
Anticipated end of shipping to repository	2036	0	2042	2018
Estimated number of canisters produced	15,000	0	4,572	340
Existing or planned storage?	Yes	No	Yes	Yes
Existing or planned storage capacity, number of canisters	750	0	4,572	340
High-Level Waste Canister Production for All Other Alternatives[b]				
Anticipated start of production	2009	2015	1996	1996
Anticipated end of production	2028	2035	2020	1998
Estimated number of canisters produced	15,000	1,700	4,572	340
Existing or planned storage?	Yes	Yes	Yes	Yes
Existing or planned storage capacity, number of canisters	15,000	1,700	4,572	340

[a] Storage capacity for 2,286 canisters currently exists at SRS. Another 2,286-canister facility has been approved and will be constructed in 2007. Impacts from constructing the second canister storage facility have been included in the WM PEIS analysis.
[b] If there is a delay in the schedule for a geologic repository, all timelines would require adjustment.

be produced at INEL in addition to the 1,700 assumed at INEL. At SRS, the additional 200 canisters would represent an increase of 4.4%, and at INEL, the 300 additional canisters would represent an increase of 18%.

9.2.4 Transportation

Transportation by truck is assumed in most calculations. The WM PEIS assumed that a truck cask would contain only a single HLW canister and that five HLW canisters would be shipped per rail cask; therefore, transportation by rail would reduce the number of trips by at least 80%. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines; however, because the routes were determined for the purpose of risk assessment, they do not necessarily represent actual routes that would be used to transport HLW in the future. Actual HLW routes will be determined during the transportation planning process described in Section 4.3.10.

Under all alternatives, DOE would be required to complete designs and obtain the necessary certification for transport of casks for HLW canisters to either another site or a geologic repository along transportation routes approved by the DOT. In addition, transportation of all DOE radioactive material would conform to the Hazardous Materials Transportation Act and applicable DOT and NRC regulations.

Transportation of hazardous and radioactive materials, substances, and wastes is governed by the U.S. Department of Transportation, NRC, and EPA regulations and by the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

9.3 High-Level Waste Alternatives

DOE analyzed five alternatives for HLW within the four broad categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. The foldout table at the end of this chapter shows the sites at which HLW would be stored under each alternative. This table is designed to be used as a quick reference when reading the HLW impact sections.

Each of the alternatives was developed in order to capture and quantify the human health risks, environmental impacts, and costs associated with the range of HLW canister storage options, and to provide input for a decision about where to store HLW. For each of the five alternatives, DOE assumed that a geologic repository would begin accepting DOE-managed HLW in 2015 at the rate of 800 canisters a year. The schedule for acceptance of DOE-managed HLW at the repository is out of scope for this PEIS. However, for purposes of analysis, DOE also evaluated a scenario that assumed that there would be a delay in acceptance of DOE-managed HLW by a geologic repository until some time later than 2015, but at the same rate of acceptance of 800 canisters per year.

9.3.1 NO ACTION ALTERNATIVE

Under the No Action Alternative, only existing and approved HLW canister storage facilities would be used. The existing HLW canister storage facilities include the Glass Waste Storage Building at SRS with a storage capacity of approximately 2,286 HLW canisters and the Chemical Process Cell at WVDP with a storage capacity of approximately 340 HLW canisters. In addition to these existing HLW canister storage facilities, DOE has authorized the construction of a second glass storage building at SRS having a capacity of 2,286 canisters (DOE, 1994a). DOE also approved a Hanford storage facility that would provide enough storage capacity for approximately 750 HLW canisters (DOE, 1987). This facility is expected to be operational by 2009. The more recent TWRS EIS (DOE, 1996d) considers storage for a total of 12,200 HLW canisters proposed to be produced at the Hanford Site. The WM PEIS applies the storage capacity given in the Record of Decision based on DOE (1987) as the baseline for the No Action Alternative. No HLW canister storage facility exists or is approved for INEL (DOE, 1995c).

Each site would store only those canisters produced at that site. The Hanford Site would run out of HLW canister storage capacity before HLW canister acceptance begins at a geologic repository in 2015 as planned, based on an anticipated HLW canister production rate of 790 canisters per year and the expected startup of vitrification operations in 2009. Without sufficient storage capacity for HLW canisters, the anticipated HLW vitrification operations at the Hanford Site and INEL would be interrupted or delayed until sufficient storage capacity could be built or capacity at a geologic repository is completed as planned.

Figure 9.3–1 illustrates the No Action Alternative. Table 9.3–1 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canister shipments by truck for the No Action Alternative.

Because the No Action Alternative is based on existing or approved capacity at each of the four sites and the anticipated acceptance rate by a geologic repository, the following assumptions were developed for performing the No Action Alternative analysis for this PEIS. These assumptions were necessary to allow for the processing of HLW to continue once operations began since not all sites have sufficient storage capacity and the repository is not scheduled to accept DOE-managed HLW until 2015.

HLW No Action Alternative

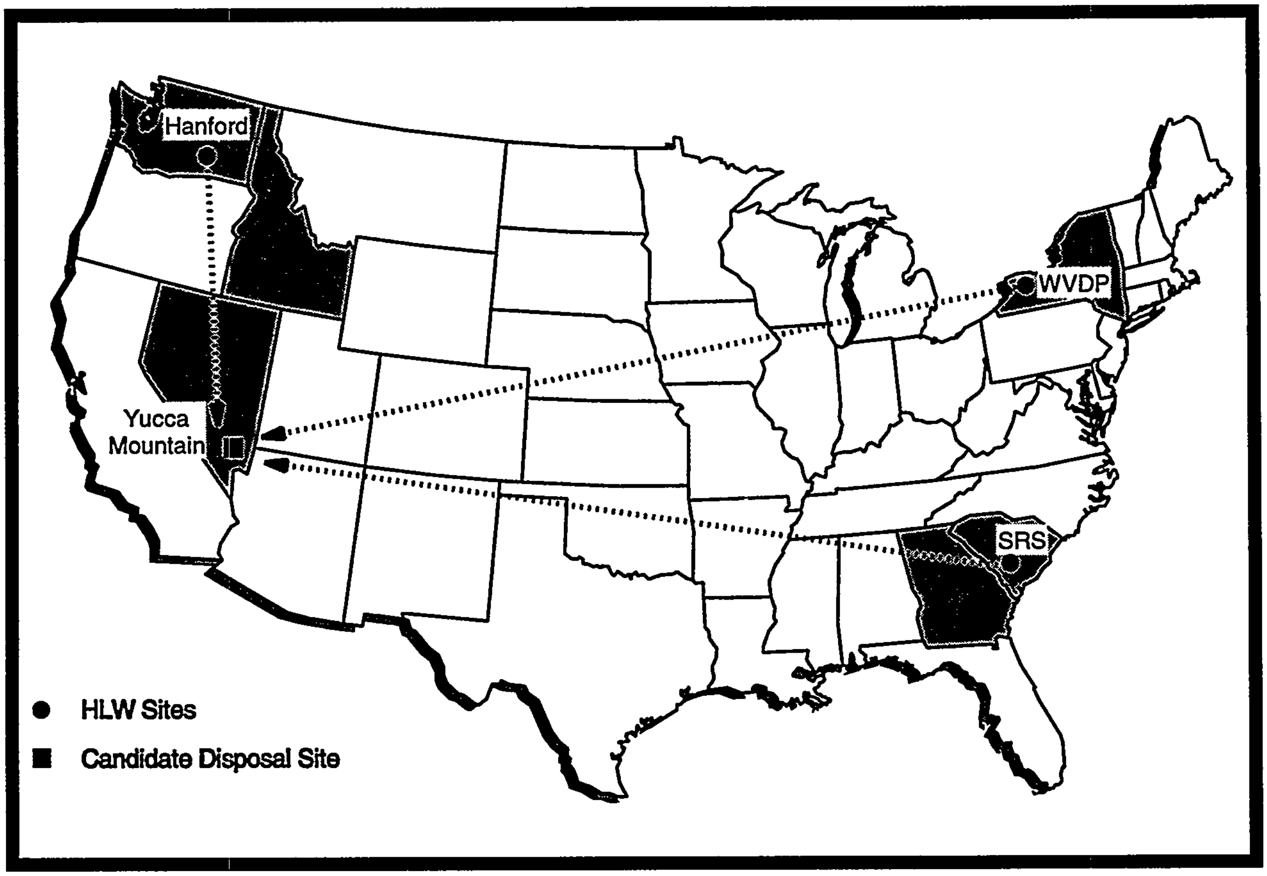

Figure 9.3–1. HLW No Action Alternative

Activity	Hanford	INEL	SRS	WVDP	Totals
Number of Canisters Stored	750	0	4,572	340	5,660
Number of Canister Shipments By Truck	15,000	0	4,572	340	19,900
Shipment Destination	Geologic Repository				

Notes: Estimated number of HLW canisters is based on HLW canister storage capacity authorized in approved NEPA documents. Although the Hanford Site has authorized storage for 750 HLW canisters, under the No Action Alternative, the Hanford Site will ultimately produce an estimated 15,000 HLW canisters.

Table 9.3–1. HLW No Action Alternative Canister Disposition

- Production of HLW canisters under the No Action Alternative would be phased in due to the lack of existing storage capacity at most of the sites and the assumed acceptance rate by a geologic repository of 800 canisters per year. Using this assumption, production of canisters would not stop once it began, but it deviates from actual site-specific planning schedules for the Hanford Site and INEL. This assumption is necessary unless a higher acceptance rate by a geologic repository is allowed.
- If a geologic repository does not begin accepting DOE-managed HLW by January 1, 2016, further delays in the start of production of HLW canisters would occur.
- WVDP—As soon as the repository begins accepting HLW canisters, WVDP would ship canisters at a rate of 100 per year. It would take approximately three years to ship all WVDP HLW canisters.
- Hanford—As soon as the repository begins accepting HLW canisters, the Hanford Site would ship canisters at a rate of 700 per year for the first three years while WVDP ships its canisters, and then ships at a rate of 800 canisters per year. It will take approximately 21 years to ship all Hanford canisters. Since the Hanford Site will construct storage capacity for 750 canisters under the No Action Alternative, DOE assumed that 750 canisters would be in storage the entire time until only 750 canisters are left and then these would be shipped in the last 2 years.
- SRS—The canisters remain in storage until all of Hanford's canisters are shipped to a geologic repository. Storage capacity exists at SRS but not at Hanford. If the Hanford Site began shipping its canisters in 2016, shipment of SRS canisters would begin in 2037 and be completed in 2042 at a rate of 800 canisters per year. If the repository does not open as scheduled, shipment of SRS canisters would start the year Hanford's shipments ended. It would take about 6 years at a rate of 800 canisters per year to ship all SRS canisters to the repository.
- INEL—INEL has no HLW storage capacity under the No Action Alternative because there are no existing or planned HLW canister storage facilities onsite and because no decision has been made on whether further treatment of the calcinated waste will occur before shipment to a repository (DOE, 1995b). The WM PEIS assumed that the final waste form would be a borosilicate glass.

9.3.2 Decentralized Alternative

Under the Decentralized Alternative, storage capacity equal to the anticipated total production of HLW canisters would be constructed at each site. This would allow each site to start generating HLW canisters as soon as the treatment facilities were available, prior to acceptance by a geologic repository. With adequate storage capacity at all four sites until canister acceptance at a geologic repository in 2015, no delays in the production of HLW canisters would occur. Figure 9.3–2 illustrates the Decentralized Alternative. Table 9.3–2 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck for the Decentralized Alternative.

9.3.3 REGIONALIZED ALTERNATIVE 1

Under Regionalized Alternative 1, the HLW canisters produced at WVDP would be transported to SRS for storage in approved transportation casks. Adequate storage capacity for HLW canisters would be constructed at the Hanford Site, INEL, and SRS; the canisters would be stored there until a geologic repository opens for operation in 2015. Figure 9.3–3 illustrates Regionalized Alternative 1. Table 9.3–3 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck for Regionalized Alternative 1.

9.3.4 REGIONALIZED ALTERNATIVE 2

Under Regionalized Alternative 2, the HLW canisters produced at WVDP would be transported to the Hanford Site in approved transportation casks. Adequate storage capacity for HLW canisters would be provided at the Hanford Site, INEL, and SRS until HLW canisters were accepted at a geologic repository. Figure 9.3-4 illustrates Regionalized Alternative 2. Table 9.3-4 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck.

9.3.5 CENTRALIZED ALTERNATIVE

Under the Centralized Alternative, the HLW canisters produced at INEL, SRS, and WVDP would be transported to the Hanford Site in approved transportation casks, where adequate storage capacity for HLW waste canisters would be provided at the Hanford Site until the canisters were accepted at a geologic repository. Figure 9.3–5 illustrates the Centralized Alternative. Table 9.3–5 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck.

HLW Decentralized Alternative

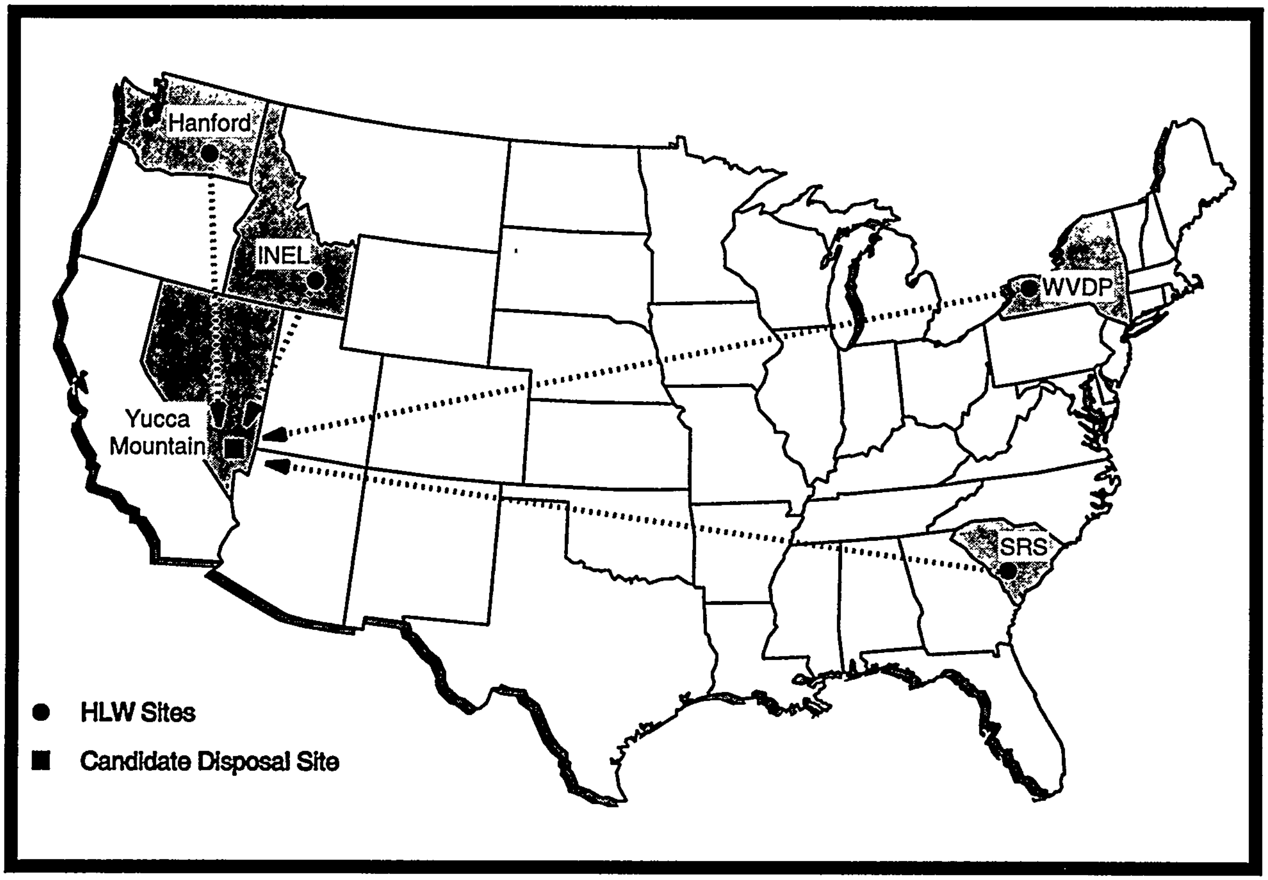

Figure 9.3-2. HLW Decentralized Alternative

Activity	Hanford	INEL	SRS	WVDP	Totals
Number of Canisters Stored	15,000	1,700	4,572	340	21,600
Number of Canister Shipments By Truck	15,000	1,700	4,572	340	21,600
Shipment Destination	Geologic Repository				

Notes: Estimated number of HLW canisters is based on total estimated HLW canister production at the site.

Table 9.3-2. HLW Decentralized Alternative Canister Disposition

HLW Regionalized Alternative 1

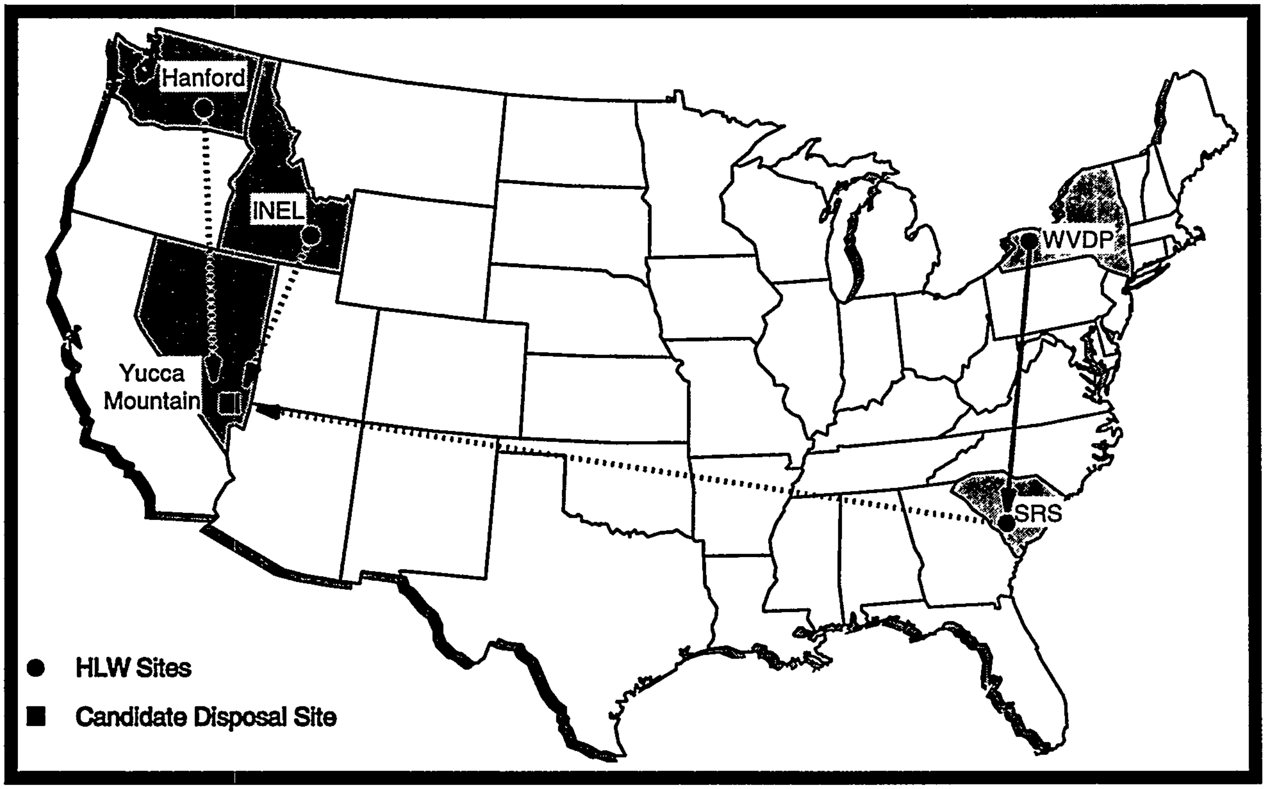

Figure 9.3-3. HLW Regionalized Alternative 1

Activity	Hanford	INEL	SRS[a]	WVDP	Totals
Number of Canisters Stored	15,000	1,700	4,912	0	21,600
Number of Canister Shipments By Truck	15,000	1,700	4,912	340	22,000
Shipment Destination	Geologic Repository			Storage at SRS	

[a] This total number includes the 340 HLW canisters from WVDP that were initially shipped to SRS.

Table 9.3-3. HLW Regionalized Alternative 1 Canister Disposition

HLW Regionalized Alternative 2

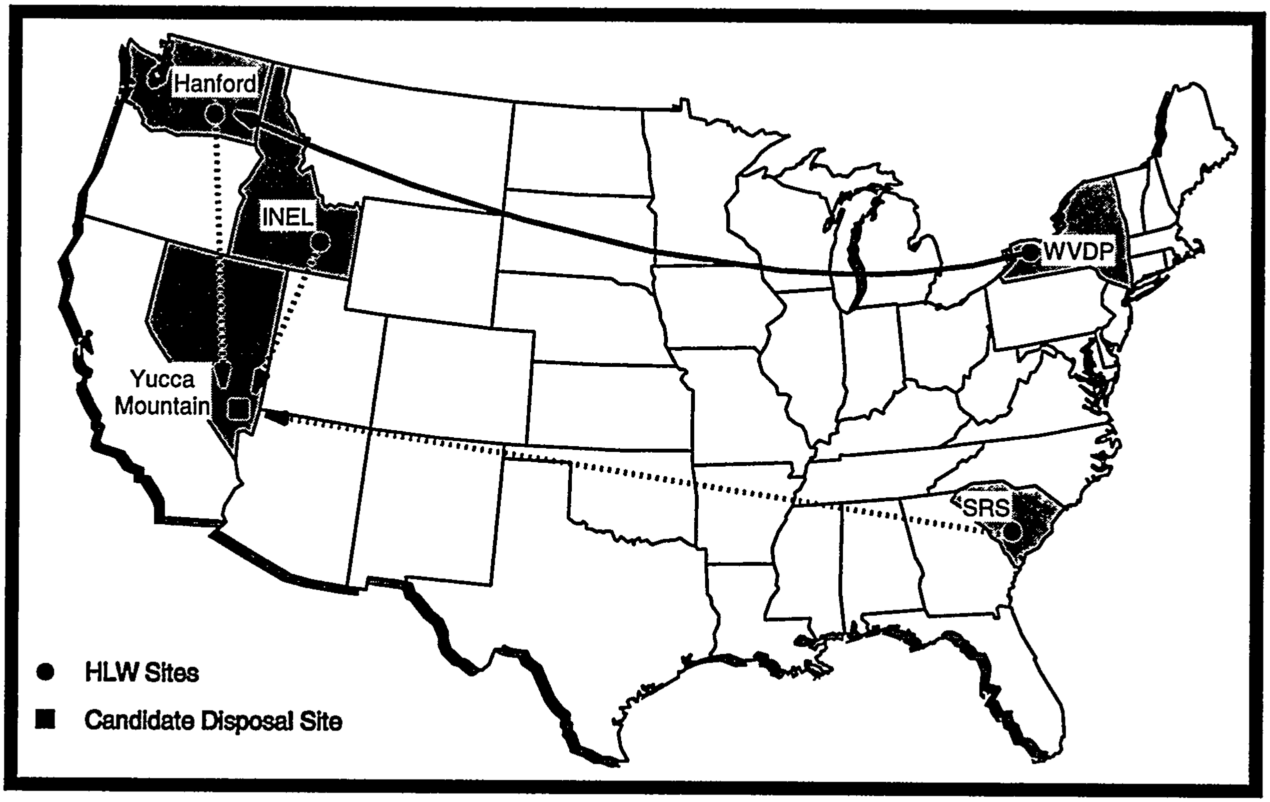

Figure 9.3-4. HLW Regionalized Alternative 2

Activity	Hanford[a]	INEL	SRS	WVDP	Totals
Number of Canisters Stored	15,340	1,700	4,572	0	21,600
Number of Canister Shipments By Truck	15,340	1,700	4,572	340	22,000
Shipment Destination	Geologic Repository			Storage at Hanford	

[a] This number includes the 340 HLW canisters from WVDP that were initially shipped to the Hanford Site.

Table 9.3-4. HLW Regionalized Alternative 2 Canister Disposition

HLW Centralized Alternative—Shipment to Repository in 2015

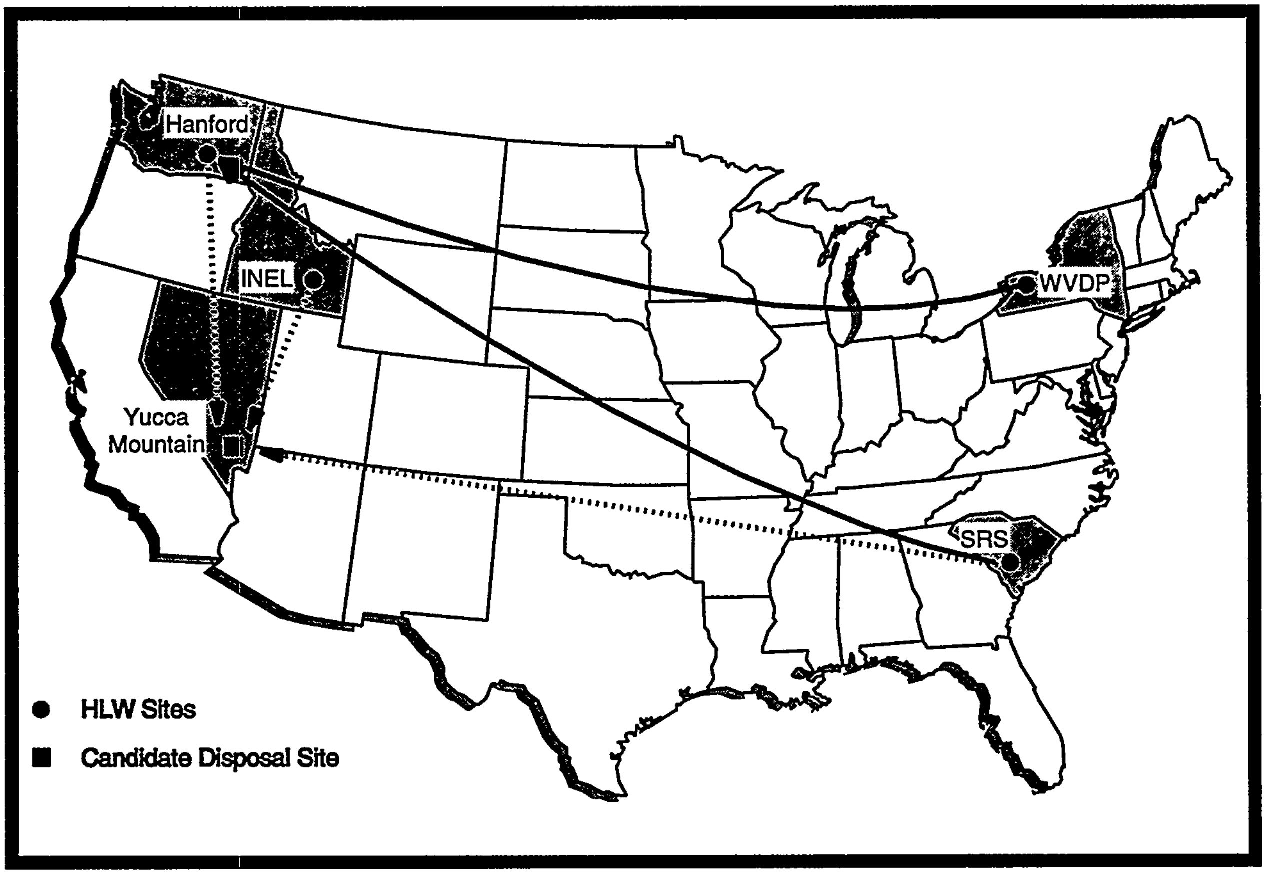

Figure 9.3–5. HLW Centralized Alternative—Geologic Repository Operates in 2015

Activity	Hanford[a]	INEL	SRS		WVDP	Totals
Number of Canisters Stored	17,500	1,700	2,199		0	21,600
Number of Canister Shipments	17,500	1,700	2,199	2,373	340	24,300
Shipment Destination	Geologic Repository	Geologic Repository		Storage at Hanford		

[a] Geologic repository begins accepting DOE-managed HLW in 2015: number of HLW canisters stored and shipped includes the 340 from WVDP and 2,373 from SRS that were initially shipped to the Hanford Site.

Table 9.3–5. HLW Centralized Alternative—Geologic Repository Operates in 2015

If this alternative were selected, the Hanford Site Tri-Party Agreement (1994) may have to be modified in consultation with the State of Washington to include a provision for the storage of INEL, SRS, and WVDP HLW canisters and modify the start-up and completion construction dates for the Hanford Site canister storage facility.

Because the WM PEIS analyzed two different timing assumptions for acceptance of HLW at the repository, the assumptions for the Centralized Alternatives vary. The WM PEIS assumed only that HLW canisters produced before the repository begins accepting DOE-managed HLW in 2015 would be shipped to the Hanford Site for Centralized storage. The remaining canisters produced at SRS and INEL after 2015 would be shipped directly to the repository. WVDP produces all its canisters prior to 2015; therefore, all 340 canisters would be shipped to the Hanford Site. This would be the basis for only a fraction of the total number of canisters being centrally stored at the Hanford Site. For the scenario where acceptance of DOE-managed HLW at the repository is delayed past 2015, all canisters produced at WVDP, SRS, and INEL would be shipped to the Hanford Site for storage prior to shipment to the repository once it begins accepting HLW; this scenario is illustrated in Figure 9.3-6 and Table 9.3-6.

9.3.6 Rationale for Selecting Storage Sites

The five HLW storage alternatives were developed to cover the range of reasonable alternatives. From one to four sites are available for storage of HLW canisters (the Centralized and Decentralized Alternatives, respectively). DOE selected two intermediate alternatives, transporting the relatively small amount of WVDP HLW canisters to either the Hanford Site or SRS. To select the Regionalized Alternatives, DOE focused on the sites with the largest amount of HLW canisters (Hanford) and where transportation would be minimized (SRS). INEL was eliminated from consideration as a Regionalized Alternative site because it has no existing or approved storage facilities.

In the Centralized Alternative, all HLW canisters would be shipped to the Hanford Site for storage. The Hanford Site was selected because it is a reasonable estimate of the impacts no matter which site is ultimately selected. The major variable is the total miles transported between existing DOE sites, the central storage site and the repository. Consolidating all HLW canisters at the Hanford Site minimizes transportation for Centralized storage, because the largest number of canisters (those produced at Hanford) would be shipped directly to the repository. Choosing an eastern site is not considered reasonable because

HLW Centralized Alternative—Shipment to Repository Later Than 2015

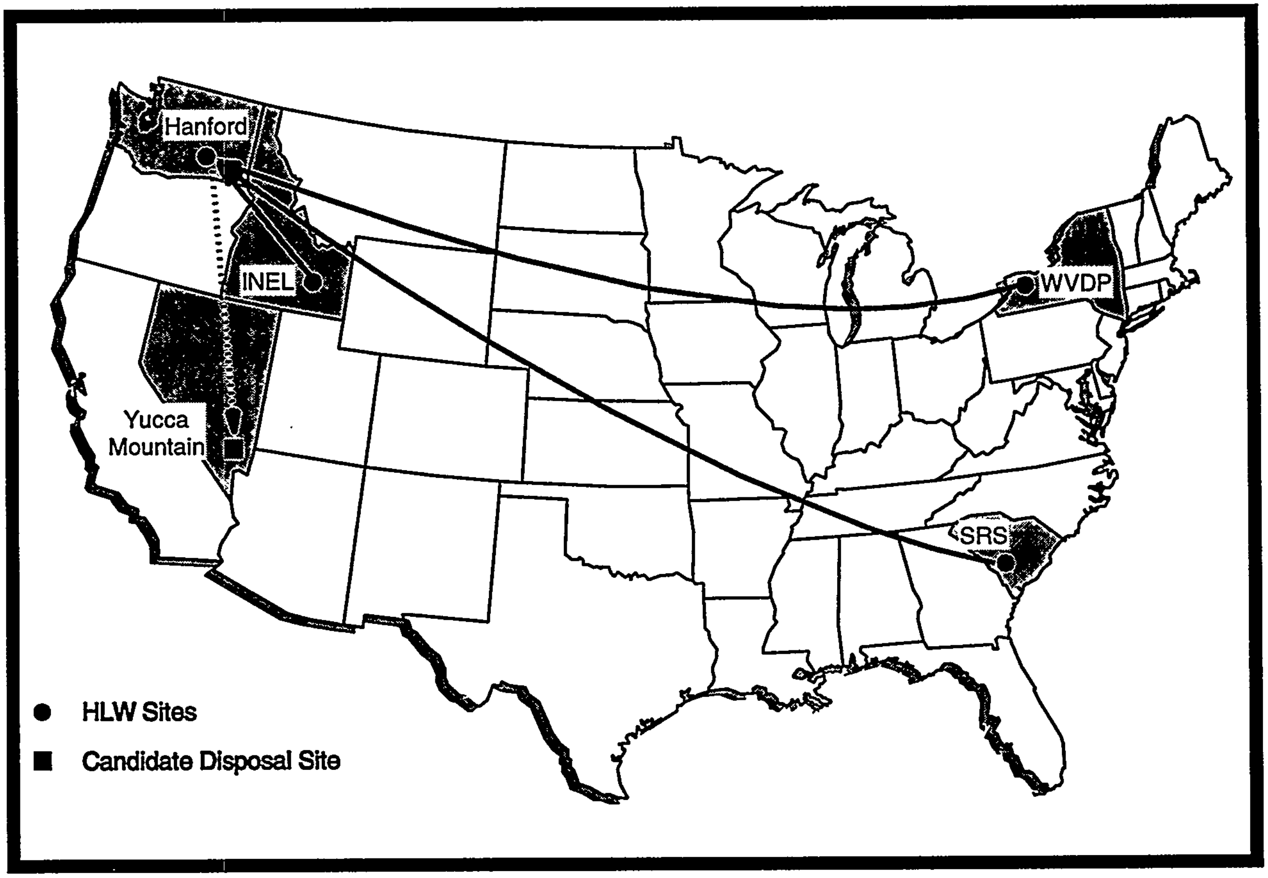

Figure 9.3-6. HLW Centralized Alternative—Geologic Repository Operates Later Than 2015

Activity	Hanford[a]	INEL	SRS	WVDP	Totals
Number of Canisters Stored	21,600	0	0	0	21,600
Number of Canister Shipments	21,600	1,700	4,572	340	28,200
Shipment Destination	Geologic Repository	Storage at Hanford			

[a] Acceptance of DOE-managed HLW at a geologic repository is delayed past 2015: number of HLW canisters stored and shipped includes 340 from WVDP, 4,572 from SRS, and 1,700 from INEL that were initially shipped to the Hanford Site.

Table 9.3-6. HLW Centralized Alternative—Geologic Repository Operates Later Than 2015 it would require the greatest number of canisters (those at Hanford and INEL) to be transported twice across the United States (the only site currently under consideration as a candidate repository is Yucca Mountain, Nevada). WVDP was eliminated from consideration for the Centralized Alternative because it has the smallest volume of HLW canisters, only 1.6% of the total HLW canisters, and would be inconsistent with the West Valley Demonstration Project Act.

9.4 Health Risks

Both fatalities and cancer incidences for WM workers are comparable for the Decentralized, Regionalized, and Centralized Alternatives and do not favor one alternative over another. Worker cancer fatalities from radiation exposure exceed fatalities from physical hazards. Transportation risks are approximately the same for all alternatives.

Health risk impacts can result from exposure to radiation and from physical trauma associated with constructing and operating storage facilities or transporting waste. Health effects resulting from radiation, whether from sources external or internal to the body, can affect either the exposed individual (known as a "somatic" effect [e.g., cancer]) or descendants of the exposed individual (known as a "genetic" effect). This section discusses the estimated adverse health impacts resulting from radiation exposure as well as the physical hazards for each HLW storage alternative. Details of the HLW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5 and in ORNL technical reports (ORNL, 1995a-c).

The potential health risks from the construction and routine operation of HLW storage facilities were evaluated for the waste management worker population (or "WM workers"). The WM worker population includes onsite employees working in a site's waste management facilities, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste. Other receptor groups were not considered for routine facility operation impacts. The offsite population and noninvolved worker population (see Section 5.4.1.2) were considered in the evaluation of potential HLW storage facility accidents (Section 9.4.3).

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer fatalities from radiation exposure

- Cancer incidences from radiation exposure
- Genetic effects from radiation exposure

9.4 *Health Risks*
9.5 *Air Quality Impacts*
9.6 *Water Resources Impacts*
9.7 *Ecological Resources Impacts*
9.8 *Economic Impacts*
9.9 *Population Impacts*
9.10 *Environmental Justice Concerns*
9.11 *Land Use Impacts*
9.12 *Infrastructure Impacts*
9.13 *Cultural Resources Impacts*
9.14 *Costs*
9.15 *Comparison of Alternatives Summary*

9.4.1 ROUTINE OPERATION IMPACTS

For operations involving storage of HLW canisters, waste management workers directly involved in storage activities are the only population of concern for potential adverse health effects. Waste management workers are at risk of developing adverse health effects as a result of the external dose from the presence of high activity radionuclides in vitrified HLW and from physical trauma resulting from storage facility construction and operation accidents. Health risks from the chemical constituents of vitrified HLW canisters in storage are not estimated since vitrifying the HLW minimizes the exposure to workers and the public. Waste management worker health risks are presented as the *total number* of workers who are estimated to experience adverse health impacts if a particular alternative is implemented. Table 9.4–1 provides the number of waste management storage workers analyzed by alternative. These numbers are derived from generic baselines which established the number of personnel required to operate storage facilities needed to manage a given number of canisters.

Worker risks associated with physical hazards were evaluated for between 20 and 45 years of construction and operation, depending on the site. In addition, these estimates included risks due to loading HLW canisters into storage, storage, and loading HLW canisters onto trucks for shipment. Worker risks from direct radiation exposure were evaluated for an entire lifetime (70 years), because health impacts could occur throughout the lifetime of the exposed individual.

Table 9.4–2 provides an overview of the health risk endpoints, hazard sources, pathways, and exposure periods evaluated for HLW canister storage.

This human health risk analysis includes evaluation of both the potential numbers of fatal cancers as well as the numbers of total cancer incidences induced by exposure to radionuclides and direct radiation. The

Table 9.4–1. Waste Management Storage Workers Population by Alternative

Site	WM Storage Workers Population by Alternative[a]				
	No Action	Decentralized	Regionalized 1	Regionalized 2	Centralized
Hanford	113	197	197	197	210
INEL	0	81	81	81	81
SRS	102	102	102	102	93
WVDP	23	23	23	23	23

[a] Values represent the number of full-time equivalents (FTEs) over the entire storage period evaluated.

Table 9.4–2. HLW Health Risk Analysis Components

HLW Canister Storage					
Endpoints	**Receptor**	**Source**	**Pathways**	**Exposure Period**	**Table Reference**
Number of trauma fatalities	WM workers	Physical hazards	Physical hazards	20–45 years[a]	9.4–4
Number of cancer fatalities	WM workers	Radionuclides	Inhalation, direct radiation	10–35 years	9.4–4
Number of cancer incidences	WM workers	Radionuclides	Inhalation, direct radiation	10–35 years	9.4–6
Number of genetic effects	WM workers	Radionuclides	Inhalation, direct radiation	10–35 years	9.4–6

[a] Period includes 10-year duration of construction.

numbers of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases.

9.4.1.1 Estimated Number of Fatalities

Table 9.4–3 presents an overview, by alternative, of the total program wide fatalities associated with storage of HLW canisters until the repository begins accepting DOE-managed HLW in 2015. For HLW operations, fatalities resulting from direct radiation exposure are estimated to be greater than those from physical hazards for all alternatives.

Table 9.4-3. HLW Canister Storage: Estimated Number of Fatalities Programwide

Alternative	Number of Storage Sites	Storage Acceptance at the Repository Beginning in 2015	
		WM Worker Radiation Exposure	WM Worker Physical Hazards
No Action	4	2	1
Decentralized	4	3	1
Regionalized 1	3	3	1
Regionalized 2	3	3	2
Centralized	1	3	2

Understanding Scientific Notation

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10
$10^1 = 10 \times 1 = 10$
$10^2 = 10 \times 10 = 100$
and so on, therefore,
$10^6 = 1{,}000{,}000$ *(or 1 million)*
etc.

Negative Powers of 10
$10^{-1} = 1/10 = 0.1$
$10^{-2} = 1/100 = 0.01$
and so on, therefore,
$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^5 can also be written as 3.0E+05, and 3×10^{-5} is equivalent to 3.0E–05. Therefore, 3.0E+05 = 300,000 and 3.0E–05 = 0.00003.

The health risk data tables in this section use "E" notation with negative exponents. Probability is expressed as a number between 0 and 1. The notation 3.0E–06 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., total cancer) will occur in the period covered by the analysis.

On a site-level basis, the number of latent cancer fatalities from direct radiation exposure is estimated to equal or exceed one only at the Hanford Site under all alternatives and at SRS under No Action and Regionalized Alternative 1. Estimated latent cancer fatalities for HLW can be found in Volume II in the site data tables for Hanford, INEL, SRS, and WVDP.

Cancer fatalities were also evaluated as annual incremental risks for each year past 2015 if acceptance of DOE-managed HLW by the repository is delayed. Estimated annual fatality risks for both radiation exposure (cancer) and physical hazards varied slightly from site to site; however, for a given site, the estimated values were generally constant across the proposed alternatives. These values are presented in Table 9.4–4.

9.4.1.2 Estimated Number of Cancer Incidences and Genetic Effects

Table 9.4–5 presents an overview, by alternative, of the total programwide estimated cancer incidences and genetic effects associated with direct radiation exposure received as a result of storage of HLW until the repository begins accepting DOE-managed HLW in 2015. Cancer incidence is estimated to exceed one under each alternative; the No Action Alternative has the lowest estimated number of radiation-induced latent cancers. Genetic effects incidence equal to one was estimated only under the Centralized Alternative.

Table 9.4–4. HLW Storage: Incremental Annual Exposure Risks Associated With Storage Beyond 2015

Alternative	Hanford		INEL		SRS		WVDP	
	WM Worker Radiation Exposure Fatalities	WM Worker Physical Hazard Fatalities	WM Worker Radiation Exposure Fatalities	WM Worker Physical Hazard Fatalities	WM Worker Radiation Exposure Fatalities	WM Worker Physical Hazard Fatalities	WM Worker Radiation Exposure Fatalities	WM Worker Physical Hazard Fatalities
No Action	2E–03	1E–03	0	0	7E–03	3E–03	2E–03	7E–04
Decentralized	4E–02	2E–02	3E–03	1E–03	7E–03	3E–03	2E–03	7E–04
Regionalized 1	4E–02	2E–02	3E–03	1E–03	7E–03	3E–03	0	0
Regionalized 2	4E–02	2E–02	3E–03	1E–03	7E–03	3E–03	0	0
Centralized	5E–02	2E–02	0	0	0	0	0	0

Table 9.4-5. HLW Canister Storage: Estimated Number of Cancer Incidences and Genetic Effects Programwide

Alternative	Number of Storage Sites	Storage Assuming Acceptance at the Repository Beginning in 2015		
		WM Worker Population Dose (person-rem)	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects
No Action	4	5,400	8	*
Decentralized	4	8,100	11	*
Regionalized 1	3	8,100	11	*
Regionalized 2	3	8,200	12	*
Centralized	1	8,400	12	1

Note: * = greater than 0 but less than 0.5.

On a site-level basis, estimated cancer incidences equaled or exceeded one at the Hanford Site, INEL, and SRS under all alternatives. Genetic effects incidence was not estimated to exceed one at any site under any alternative. Estimated cancer incidences and genetic effects for HLW can be found in Volume II in the site data tables for Hanford, INEL, SRS, and WVDP.

Estimated cancer incidence and genetic effects incidence were evaluated as annual incremental risks for each year past 2015 if acceptance of DOE-managed HLW by the repository is delayed. Estimated annual cancer incidence and genetic effects risks varied slightly from site to site; however, for a given site, the estimated values were generally constant across the proposed alternatives. The estimated annual cancer incidence and genetic effects incidence risks are presented in Table 9.4-6.

9.4.2 Transportation-Related Impacts

The transportation of HLW canisters between sites and to the repository is expected to affect the health of the truck or rail crew and the public along the transportation route because of exposure to radiation and vehicle exhaust and physical trauma from vehicle accidents. Appendix E contains a description of the methods used to estimate transportation risks.

Table 9.4–6. HLW Storage: Incremental Annual Exposure Risks Associated With Storage Beyond 2015

Alternative	Hanford		INEL		SRS		WVDP	
	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects
No Action	8E–03	4E–04	0	0	3E–02	1E–03	6E–03	2E–04
Decentralized	1E–01	5E–03	1E–02	5E–04	3E–02	1E–03	6E–03	2E–04
Regionalized 1	1E–01	5E–03	1E–02	5E–04	3E–02	1E–03	0	0
Regionalized 2	1E–01	5E–03	1E–02	5E–04	3E–02	1E–03	0	0
Centralized	2E–01	8E–03	0	0	0	0	0	0

Table 9.4–7 presents the estimated transportation fatality totals for workers and the public resulting from radiation exposure associated with vitrified HLW canisters and vehicle exhaust emissions, as well as from vehicle accidents. Shipment of vitrified HLW canisters by truck is estimated to produce approximately five deaths in the crew and the public from radiological exposure and traffic accident injuries, whereas, one death might be expected from rail shipments. The estimated number of radiation-induced cancer fatalities listed in Table 9.4–7 is higher for the public than the crew because the public, as a group of receptors, contains more individuals than the crew. As described in Appendix E, the public includes individuals living along the transportation route, people traveling along the highway, and individuals at rest stops. The public would receive a higher collective dose than the crew, but more individuals of the public are potentially exposed, with a single member of the public receiving a much lower dose than a member of the crew.

9.4.3 FACILITY ACCIDENT IMPACTS

Vitrified HLW is very stable; therefore, the only accident likely to occur is the dropping of a vitrified HLW canister in a storage facility. To determine the consequences of a storage facility accident, a hypothetical accident was analyzed in

> ***Maximally Exposed Individual (MEI)***
>
> *In keeping with the standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants.*

Table 9.4–7. HLW Truck and Rail Transportation: Estimated Fatalities From Vehicular Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Shipments		Shipment Miles in Millions		Estimated Number of Radiological Fatalities[a]					
					Routine Operations Public		Routine Operations Crew		Exposure From Traffic Accidents	
	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
No Action	19,912	3,983	29.4	6.68	2	*	1	*	*	*
Decentralized	21,612	4,323	30.7	6.93	2	*	1	*	*	*
Regionalized 1	21,952	4,391	31.0	7.04	2	*	1	*	*	*
Regionalized 2	21,952	4,391	31.2	7.03	2	*	1	*	*	*
Centralized 1[b]	24,325	4,866	34.6	7.70	2	*	1	*	*	*
Centralized 2[c]	28,224	5,646	39.5	8.74	2	*	1	*	*	*

Alternative	Number of Shipments		Shipment Miles in Millions		Estimated Number of Nonradiological Fatalities			
					Fuel Emission		Injury From Traffic Accidents	
	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
No Action	19,912	3,983	29.4	6.68	*	*	2	*
Decentralized	21,612	4,323	30.7	6.93	*	*	2	*
Regionalized 1	21,952	4,391	31.0	7.04	*	*	2	*
Regionalized 2	21,952	4,391	31.2	7.03	*	*	2	*
Centralized 1[b]	24,325	4,866	34.6	7.70	*	*	2	*
Centralized 2[c]	28,224	5,646	39.5	8.74	*	*	2	*

Notes: * = greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced latent cancer.
[b] Centralized Alternative 1 assumes storage until repository begins accepting DOE-managed HLW in 2015.
[c] Centralized Alternative 2 assumes acceptance at the repository is delayed past 2015.

which a severe drop caused a breach in a vitrified HLW canister. The canister would be inside a contained, shielded environment, but a small quantity of radioactive material could be released to the air because of the breach. Table 9.4–8 contains the results of the analysis for potential storage facility accidents. If a facility's HEPA filtration system was not functioning, allowing the entire quantity of contaminated air released from the canister to escape from the building, no deaths among the offsite population or workers are estimated from such an accident. Appendix D contains additional details.

Table 9.4-8. HLW Facility Accidents: Cancer Fatalities From Potential Maximum Reasonably Foreseeable Storage Facility Accidents

Filtered Canister Breach Accident	Hanford	SRS	WVDP	INEL
Offsite population	*	*	*	*
Offsite MEI	3E-08	4E-12	2E-10	2E-11
Noninvolved worker population	*	*	*	*
Noninvolved worker MEI	1E-09	4E-11	2E-11	3E-12
Waste management workers	*	*	*	*
Unfiltered Canister Breach Accident[a]				
Offsite population	*	*	*	*
Offsite MEI	3E-06	2E-06	9E-05	9E-06
Noninvolved worker population	*	*	*	*
Noninvolved worker MEI	4E-05	2E-05	1E-05	2E-06
Waste management workers	*	*	*	*

Notes: * = greater than 0 but less than 0.5; NA = not applicable. The values for offsite population, noninvolved worker population, and waste management workers are numbers of latent cancer fatalities; the values for MEIs are probabilities of fatality. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] The unfiltered canister breach accident is included due to its high consequences, even though it is not a "reasonably foreseeable" accident in terms of frequency (i.e., annual frequency of occurrence less than 1E-06).

9.4.4 Risks From Canisters From Foreign Reactor Spent Nuclear Fuel

As discussed in Section 9.2.3, additional canisters of HLW would be generated from foreign research reactor spent nuclear fuel and other sources during chemical processing. At SRS, an additional 200 canisters would represent an increase of 4.4%. At INEL, an additional 300 canisters would represent an increase of 18%. Although the WM PEIS did not quantitatively evaluate the storage and transport of these additional canisters, the incremental risks associated with their storage, handling, and shipment are expected to be small, assuming that the canisters are similar to others being managed at each site.

For canisters with comparable radiological characteristics, the additional risks would be proportional to the increase in the number of canisters. The additional canisters would add between 0.04–0.05 expected worker fatalities at SRS and approximately 0.02 worker fatalities at INEL for the range of alternatives. Truck transport of the additional canisters would increase the total HLW transport mileage by 0.6% to 3.2%, depending on the alternative selected, leading to 0.04–0.02 total additional fatalities from transportation. Transport by rail would result in even lower risks.

9.5 Air Quality Impacts

The management of HLW would not appreciably affect the air quality at any site. No criteria air pollutants would exceed standards at any site. Emissions of hazardous air pollutants (including radionuclides) and toxic air pollutants from storage facilities, were assumed to be negligible.

As illustrated in Table 9.5–1, DOE evaluated air quality impacts at each proposed HLW canister storage site based on estimated increases in emissions of the six criteria air pollutants. Hazardous air pollutant emissions (which include radionuclides), and toxic air pollutant emissions from HLW canister storage facilities were assumed to be negligible given the physical form of vitrified HLW. Once HLW is vitrified, the glass matrix binds the radionuclides and hazardous chemicals preventing releases to the atmosphere. Criteria air pollutant emission estimates were made for HLW facility construction activities and for operation and maintenance activities.

The Clean Air Act (42 USC 7401 *et seq.*) regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new sources of emissions from both "stationary" (e.g., storage facilities) and mobile (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for each criteria air pollutant. An entity which seeks to engage in an activity that will result in emissions that equal or exceed those limits in a nonattainment area must first obtain a permit.

Table 9.5–1. Air Quality Impacts Evaluated for HLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Text discussion only
	Operations and maintenance	Estimated for fuel use by HLW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Text discussion only

In "attainment areas" (where air pollution standards are met), only new sources of emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit is required for a new stationary source that equals or exceeds the allowable increase. However, a permit is not required for criteria air pollutant emissions from mobile sources.

9.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site ("mobile sources").

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities under all the HLW alternatives would result in emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. DOE chose the 10% threshold to highlight those sites where criteria air pollutant emissions could result in adverse air quality impacts.

> *Major Types of Air Pollutants*
>
> ***Criteria Air Pollutants:*** *carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*
>
> ***Hazardous Air Pollutants:*** *189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*
>
> ***Toxic Air Pollutants:*** *Other toxic compounds regulated by EPA and state or local governments*

DOE estimates that no site would have emissions from construction activities that would equal or exceed 10% of allowable levels. Therefore, no site would need to obtain a Clean Air Act permit.

9.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants are also emitted during operations and maintenance (O&M) of HLW facilities ("stationary sources") and by vehicles that are driven by workers to the facility or used to transport waste ("mobile sources"). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

DOE estimates that no site would have emissions from O&M activities that would equal or exceed 10% of allowable levels. Therefore, no site would need to obtain a Clean Air Act permit.

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 km (62 miles) of a PSD Class I area. INEL is the only site proposed for HLW activities that is located within 100 km of a PSD Class I area, although emissions would be below levels that may affect a Class I area.

Concentrations resulting from criteria air pollutant emissions from stationary-sources were not compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50) since there would be no stationary-sources (treatment facilities) for HLW.

9.5.3 Hazardous and Toxic Air Pollutant Emissions

Hazardous air pollutant (which include radionuclides) and toxic air pollutant emissions from HLW canister storage facilities were assumed to be negligible due to the physical form of the vitrified HLW. Once HLW is vitrified, the glass matrix binds the radionuclides and hazardous chemicals, such that releases to the atmosphere are negligible.

9.6 Water Resources Impacts

Major impacts to water resources at all affected sites are unlikely even if the HLW repository does not begin to accept DOE-managed HLW in 2015 and long-term storage of HLW canisters at the sites is required.

As illustrated in Table 9.6–1, DOE analyzed the impacts on water resources of HLW canister storage activities. DOE evaluated the effects on water availability from building and operating storage facilities. The impacts of long-term storage were also evaluated should the HLW repository be unable to accept DOE HLW beginning in 2015.

Table 9.6–1. Water Resource Impacts Evaluated for HLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used: • by personnel • by storage processes	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

9.6.1 Water Availability

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of HLW canister storage facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to a major offsite stream at a given site.

As shown in the Volume II tables, projected water usage would increase by more than 1% only at WVDP. The 1% threshold is based on the assumption that lesser changes are not likely to have significant impacts.

Water use at WVDP would be 1.4% of current use for all alternatives under both sets of timing assumptions. The 1,000 gallons per day required for operations at WVDP would be supplied by surface water taken from two onsite reservoirs. Since normal household water use in the United States is estimated at approximately 105 gallons per day per person (Solley et al., 1988), water use rates that are equivalent to the water used by approximately 10 people are unlikely to cause major changes in surface water flow rates and levels.

As shown in the Volume II tables, for DOE sites that withdraw water directly from a surface water source (the Hanford Site and WVDP), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (SRS and WVDP), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

9.6.2 Water Quality

Impacts to groundwater quality were not evaluated for HLW since disposal is not within the scope of the WM PEIS. However, groundwater quality will be addressed in the environmental impact statement for the repository.

9.7 Ecological Resources Impacts

Loss of limited acreages of habitat at the DOE sites during construction of HLW canister storage facilities should not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. Operation of HLW canister storage facilities would not affect ecological resources because airborne emissions and liquid effluents are expected to be negligible. DOE would be able to locate new HLW canister storage facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction site acreages are small compared to the total acreage at each site suitable for waste operations. When specific HLW facility locations are proposed, DOE will conduct site- and project-level analyses to determine if any sensitive species, including Federally and State-listed endangered and threatened species, may be affected and will establish appropriate protection measures. Transportation accidents involving shipment of HLW canisters would be extremely rare and would not affect aquatic habitats because of the vitrified form of the HLW and special packaging.

DOE analyzed the ecological impacts of constructing HLW canister storage facilities (Table 9.7–1). The ecological impacts of operating HLW canister storage facilities and shipping HLW canisters among sites or to a geologic repository were not analyzed quantitatively. Airborne emissions and liquid effluents from HLW canister storage facilities and any resulting exposures of nearby ecological communities are expected to be negligible. HLW transportation accidents involving a spill into an aquatic environment are expected

Table 9.7–1. Ecological Resources Impacts Evaluated for HLW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at HLW construction sites to general habitat range	Text discussion
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats by comparing construction acreage to available acreage of nonsensitive habitats	Text discussion
Sensitive species concerns	Sensitive species including Federally and State-listed endangered and threatened species	Numbers of Federally and State-listed species displayed by site/alternative	Text discussion

to be extremely rare. Even if such an accident does occur, the vitrified form of HLW, and the design of the Type B shipping cask will prevent any substantial release of radionuclides. Type B shipping casks are designed to maintain the integrity of the package with essentially no loss of radionuclide content or serious impairment of the shielding capability even in a severe accident.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

9.7.1 General Impacts of Site Clearing

The extent of construction site clearing would be extremely small for any HLW alternative at any site relative to the extent of the general habitats supported at the sites. Acreage requirements for alternatives involving storage of HLW canisters ranged from 1 acre at the Hanford Site under the No Action Alternative to 16 acres at the Hanford Site under the Centralized Alternative. Therefore, although site clearing will destroy individual plants and will kill or displace individual animals, particularly small mammals and song birds with limited home ranges, no significant effects to general species populations or communities are expected from implementation of any HLW alternatives.

9.7.2 Site Clearing Effects on Sensitive Habitats

All four HLW sites contain sensitive habitats. The closer the HLW canister storage facility construction activities are to those habitats, the more likely that they would be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment. Avoiding such impacts depends on DOE's ability to avoid locating the facilities near these habitats. A measure of this ability is the percentage of available land that facility construction under any HLW alternative requires at a site. Available acreage was estimated from site development plans, either as land designated for waste operations or by subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage ranged from 0.001% under several alternatives to about 0.26% at the Hanford Site under the Centralized

Alternative. DOE would therefore have a great degree of flexibility in siting facilities and effects on sensitive habitats should be avoided. Even if these habitats could not be avoided, mitigation measures could be employed.

Aquatic resources may be indirectly affected through increased runoff and sedimentation loadings to surface waters from disturbed terrestrial areas. However, the use of various mitigation techniques should minimize potential storage facility construction impacts to aquatic ecological resources. Direct discharges to surface waters from the routine operation of HLW canister storage facilities are expected to be limited by the use of engineering control practices. Therefore, the impacts to aquatic organisms are expected to be minimal.

9.7.3 Consideration of Sensitive Species

Federally and State-listed endangered species can be found on all four HLW sites. The number of species occurring or potentially occurring at each of the HLW sites is—the Hanford Site: 3/11, INEL: 2/2, SRS: 8/8, and WVDP: 1/8; where the first number indicates Federally listed species and the second number indicates State-listed species. No major construction is proposed at WVDP under any of the HLW alternatives nor INEL under the No Action Alternative. Major construction actions are proposed at INEL for all other alternatives and at the Hanford Site and SRS under all HLW alternatives. However, site-specific analysis would be required to assess these impacts. Such analysis would take into account specific siting locations for the HLW canister storage facilities in relation to the location of sensitive habitats and sensitive species at each site, including those listed by the U.S. Fish and Wildlife Service as endangered or threatened.

9.7.4 Effects of HLW Transportation Accidents

The ecological impacts of a transportation accident involving shipment of HLW canisters on aquatic environments are expected to be minimal. Like TRUW, HLW will be shipped in type B Casks/Containers, which should limit any potential release of radionuclides or hazardous chemicals in the waste to surface waters. In addition, vitrification of the HLW further limits any potential releases if the shipping casks were breached during an accident.

9.8 Economic Impacts

HLW canister storage facility construction and operations expenditures would minimally benefit the local economy at the four HLW sites because estimated job and personal income for all HLW alternatives are well below 1% of regional employment and income at all sites. None of the HLW alternatives would significantly affect the national economy, although 400 to 1,400 jobs would be directly or indirectly financed.

DOE estimated the effects of expenditures for HLW management on the local and national economies. Local economic effects were based on direct expenditures at each site for construction, operation and maintenance, and decontamination of HLW canister storage facilities. The socioeconomic region of influence (ROI), consists essentially of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data. Local increases in jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at a national level only.

Local economic effects were estimated on an annual basis (Table 9.8–1). Activities at the HLW sites vary from site to site among alternatives, many continuing well beyond the anticipated repository acceptance date of 2015.

Because the regional economies are subject to changes induced by many different variables other than DOE expenditures, DOE believed that estimating economic benefits beyond 2015 would be speculative. Therefore, the analysis was confined to estimating the economic effects of the total HLW canister storage facility construction and operations expenditures at each site for the 20-year period from 1996 to 2015. Costs beyond 2015 were not used to estimate economic benefits but are compared to show overall HLW alternative differences. Five years was added to the base 20-year period for determining annual economic impacts to account for the continued effects of DOE expenditures on employment and income after the end of the base period. Job and personal income increases are shown for each site in the Volume II site tables.

Table 9.8–1. Economic Impacts Evaluated for HLW Alternatives

Economic Effects Analyzed	Affected Economic Resource	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional employment multiplier at each HLW site	Text discussion
Increased regional incomes	Regional personal income	Proposed site expenditures multiplied by regional income multiplier at each HLW site	Text discussion
National economic effects	National economy	Proposed site expenditures plus total transportation expenditures multiplied by national employment and income multipliers	Text discussion
Costs beyond the year 2015	Continued annual program effects on regional and national employment and personal income	Display minimum and maximum costs beyond 2015 by site and alternative	Text discussion

9.8.1 ACCEPTANCE AT THE REPOSITORY BEGINNING IN 2015

Across the HLW alternatives, none of the sites would experience a 1% or greater increase in the number of jobs or in personal income between 1996 and 2015 as a result of expenditures for HLW. A comparison of alternatives reveals that the number of new direct, indirect, and induced jobs from the construction and operation and maintenance activities in the ROIs range from 410 (under the No Action Alternative) to 670 (under the Regionalized 2 Alternative).

In addition to an evaluation of the effects on the regional economy, a comparison of these effects was made on the national economy. None of the HLW alternatives would substantially affect employment in the national economy. The number of jobs generated in the national economy from combined weighted construction and operations phase activities ranges from 480 under the No Action Alternative to 1,200 under the Centralized Alternative. Although the number of jobs appears large in absolute terms, 1,200 jobs represent 0.0009% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. It is likely that any changes would represent a shift in the source of income from previous employment to employment in HLW projects, rather than a net change in national personal income.

9.8.2 Repository Acceptance Delayed Past 2015

Across the HLW alternatives, none of the sites would experience a 1% or greater change in jobs or personal income. The number of new direct, indirect, and induced jobs from HLW canister activities between 1996 and 2015 ranges from 410 (under the No Action Alternative) to 690 (under the Centralized Alternative).

The HLW alternative would only minimally benefit employment in the national economy even if acceptance of HLW canisters at a geologic repository is delayed past 2015. The number of jobs generated in the national economy ranges from 480 under the No Action Alternative to almost 1,400 under the Centralized Alternative. The 1,400 jobs represent 0.001% of the 137 million jobs in the national economy. It is likely that any changes would represent a shift in the source of income from previous employment to employment in HLW canister storage projects, rather than a net change in national personal income.

Any economic impacts of expenditures beyond 2015 were not included but would derive from expenditures for additional storage of the canisters that are currently assumed to go straight to the repository. The additional interim storage at the Hanford Site, location of potential greatest impact, could cost as much as $180 million to construct storage for 3,887 additional canisters in the Centralized Alternative.

9.9 Population Impacts

The overall population in-migration remains relatively constant under all proposed alternatives and does not result in a major increase at any site. No corresponding changes to community characteristics or the provision of services would be anticipated.

Potential population changes in the ROI at each HLW site were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used to evaluate the likelihood that associated effects would result, such as changes in community size and diversity, or changes in the provision of necessary services.

Because the scope of activity and the associated labor requirement proposed under each of the alternatives is relatively small, the overall impact of population in-migration would be negligible. No site would experience ROI population increases greater than 0.1% of the current ROI population under any of the alternatives.

9.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of HLW canisters indicated that minority and low-income populations at the HLW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HLW alternatives.

Analysis of environmental justice impacts from management of HLW canisters was based on a review of the impacts reported in this chapter regarding the HLW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the four HLW sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done. Appendix C also provides maps illustrating the distribution of minority and low-income populations within 50 miles of each HLW site.

9.10.1 RESULTS

The potential is low for adverse human health effects from exposure to radionuclide emissions from HLW canister storage facility operations. The calculated risk of cancer fatalities (see Section 9.4.1) associated with storage facility operations is small for radionuclide-related cancer for the offsite maximally exposed individual. Therefore, disproportionately high and adverse health effects to any segment of the population, minorities and low-income populations included, from HLW canister storage facility accidents are not expected to occur.

9.10.1.1 Transportation

Because incident-free HLW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income populations, no environmental justice impacts are expected. As Section 9.4.2 indicates, the total number of potential fatalities is the sum of the fatalities caused by exposure to radiation and the fatalities caused by exposure to vehicular emissions. The total number of truck shipments during HLW canister storage facility operations would vary from about 20,000 under the No Action Alternative to about 28,000 shipments under the Centralized Alternative 2. The estimated total cancer fatalities resulting from incident-free transportation range from less than 0.5 to 3 fatalities under the HLW alternatives. This small number of collective population fatalities is spread across a large number of shipments. A disproportionate share of minority and low-income populations reside near interstate highways and railroads; however, the major routine risks to the public from truck transportation are from exposure during rest stops to travelers who are at the same rest stops. Minority and low-income populations are found to be disproportionately lower in representation at highway rest stops (DOT, 1992). For rail shipments, the primary risks to the public are from radiological exposure during railcar classification in railyards, primarily at the start and end of each shipment, and from the emission of diesel exhaust from the trains in urban areas.

The expected number of cancer fatalities due to radiation exposure from transportation accident releases is less than 0.5 under all alternatives. The expected number of transportation accident fatalities from trauma is also less than 0.5 under any HLW alternative. Therefore, no disproportionately high and adverse effects are expected to any particular segment of the population, including minority or low-income groups.

9.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 9.10.1 did not indicate any adverse impacts to air quality, water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Therefore, no disproportionately high and adverse environmental impacts are expected for any segment of the populations at the HLW sites, including minorities and low-income populations.

9.11 Land Use Impacts

No impacts to current onsite or offsite land uses would result from implementing any of the HLW alternatives because for all the sites, land requirements to build HLW canister storage facilities are less than 1% designated or suitable lands. In addition, the proposed HLW canister storage facilities do not conflict with the development plans for any site.

DOE examined the impacts of the alternatives on land use by comparing the acreage required for new HLW canister storage facilities to the acreage either designated for waste operations or suitable for development (see Table 9.11-1). Suitable land is the total site acreage, minus the acreage required for existing facilities and roads, known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts between the proposed facilities required under each alternative and plans for future site uses.

The land requirements analysis indicated that, for all of the sites under all the HLW alternatives, land requirements to build HLW canister storage facilities were less than 1% of designated or suitable lands. DOE should have considerable flexibility in locating HLW canister storage facilities and no land use impacts onsite are expected. For the same reason, no conflicts with adjacent land uses are expected. In addition, none of the site development plans indicated any instances where future use would conflict with the proposed HLW management actions.

Table 9.11-1. Land Use Impacts Evaluated for HLW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each HLW site	Land use shown in site development plans	Comparison of the required acreage with amount designated (or estimated) for HLW in site development plan—all instances where requirements are 1% were noted	Text discussion
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed waste management uses and nearby land uses	Text discussion

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations on a site.

9.12 Infrastructure Impacts

Proposed HLW activities show no potential for effects to onsite infrastructure. No offsite infrastructure impacts are expected at any site. Estimated new requirements for wastewater treatment at the Hanford Site increase current demand in all alternatives, except No Action. Employment increases do not approach or exceed 5% of current site employment at any site. Traffic increases would be minimal during construction, and would not affect onsite transportation infrastructure.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and electrical power (See Table 9.12–1). Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater produced by construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to the onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on community infrastructure.

Proposed HLW activities show no potential for effects on onsite infrastructure. No offsite infrastructure impacts are expected. Proposed HLW activities show no potential for effects on onsite or offsite demand for potable water, wastewater treatment, and power infrastructure.

Table 9.12–1. Infrastructure Impacts Evaluated for HLW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support HLW canister storage facilities	Capacity of onsite water, electrical power, and wastewater systems	Add increased HLW facility use to current use—compare to current capacities	Text discussion
	Onsite transportation infrastructure	Compare new site employment with current site employment as an index of increased stress	Text discussion
Capacity of community infrastructure to support increased worker populations and their families	Regional water, electrical power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion

Employment increases from the construction of HLW canister storage facilities do not approach or exceed 5% of current site employment. Therefore, it is expected that traffic increases will be minimal during construction, and will not substantially affect onsite transportation infrastructure.

9.13 Cultural Resources Impacts

Construction and operation of HLW canister storage facilities could adversely affect cultural resources. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where HLW canister storage facilities are proposed. Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys and the reported resources at the four HLW sites. However, the impacts of the construction of HLW canister storage facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

The acreage requirements at all sites under all alternatives are only a small fraction of the areas available for waste operations so DOE should be able to avoid impacts to any known cultural resources or any identified during pre-construction site surveys. If not, measures would be taken to mitigate negative effects on these resources.

9.14 Costs

The costs of storing HLW canisters remain relatively stable at approximately $3 billion, for all alternatives. Costs do rise slightly when storage is Centralized. Delay in disposing the waste at a geologic repository causes the life-cycle costs to increase at a rate of 0.2% per year of delay, not counting inflation.

As indicated in Table 9.14–1, DOE estimated costs for building and operating storage facilities for canisters of vitrified HLW and for transportation (ANL, 1996). DOE evaluated costs associated with HLW canister storage and transportation from both a life-cycle and process perspective, using 1994 dollars.

Table 9.14–1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts Are Assessed	Location of Impacts Assessment
Process Costs	Storage	Life-cycle costs for HLW canister storage facilities, including facilities and loading and unloading of canisters into and out of storage.	Table 9.14–2
Transportation Costs	Truck Rail	Inter-site common carrier costs for transportation from generating sites to storage sites, and to the candidate geologic repository.	Table 9.14–2

9.14.1 FACILITY COSTS

DOE evaluated facility costs for two phases of the life-cycle of the HLW canister storage facilities: construction and O&M costs were estimated. Facility construction cost formulas were based on similar facility estimates made by DOE for HLW vitrification and storage facilities at SRS, WVDP, the Hanford Site, and INEL. Operations and maintenance cost formulas were also based on similar storage facilities. Facility costs do not include speculative factors, such as impacts to long-term land value.

9.14.2 PROCESS COSTS

DOE also analyzed costs based on storage and handling activities. Storage costs include the construction and operation of HLW canister storage facilities. Handling costs include the loading and unloading of HLW canisters from the production line into storage, and for transportation to follow-on storage sites or to the candidate geologic repository. Based on the advanced conceptual design of the candidate geologic repository, plans are to receive 800 canisters per year from DOE (March 1994).

Transportation costs include the costs associated with the movement of the HLW canisters from one site to another for either treatment or disposal. Transportation costs are evaluated for both truck and rail shipments (ANL, 1996).

The summary of costs is shown in Table 9.14–2 (ANL, 1996). The No Action Alternative includes the production of all required canisters, but does not include storage beyond that already approved. With no increase in approved storage facilities, the canisters are shipped to the repository, phasing by site in the following order—WVDP, the Hanford Site, and SRS. No vitrification is performed at INEL because the site-specific plan has not yet been approved. When approved, the cost of the No Action Alternative will increase by $280 million. The No Action Alternative provides a baseline by which to compare the other alternatives.

Considering the Decentralized, Regionalized and Centralized Alternatives, construction accounts for 12% to 13% of the total cost, and operations account for 71% to 73% of those costs. The stability of costs is driven by the preponderance of canisters produced at the Hanford Site (15,000 of 21,600 canister total in the complex). The small variations of the Decentralized and Regionalized Alternatives costs are driven

Table 9.14-2. Life-Cycle Costs (Billions of 1994 Dollars)

Alternatives	Description	HLW—Cost in Billions of 1994 Dollars						
		Total Cost[a]	Life-Cycle Costs (Construction and O&M Phases)		Process Costs[b]		Transportation Costs	
			Construction	O&M	Storage	Handling	Truck	Rail
No Action	Current Program	1.47	0.07	1.00	0.21	0.87	0.39	0.57
Decentralized	Storage of HLW canisters at generator sites until acceptance at Repository begins in 2015	2.69	0.33	1.95	0.60	1.68	0.41	0.59
Regionalized 1	Canisters from WVDP stored at SRS	2.72	0.33	1.98	0.61	1.70	0.41	0.60
Regionalized 2	Canisters from WVDP stored at Hanford	2.72	0.33	1.98	0.61	1.70	0.41	0.60
Centralized	Canisters from WVDP and SRS stored at Hanford	2.85	0.37	2.02	0.73	1.66	0.46	0.68

[a] The facility costs in this table are presented in two ways: as life-cycle costs (construction and O&M phases) and as process costs (storage and handling only). Life-cycle costs are equal to process costs. Total costs are obtained by adding truck costs to life-cycle costs or to process costs. Thus, "total costs" = sum of life-cycle and truck costs = sum of process and truck costs.

[b] The costs of storage after the manufacture of canisters filled with vitrified HLW were included in this PEIS. The costs of storage of waste prior to treatment were included in the site infrastructure costs, which are not part of this PEIS.

by the storage of the 340 canisters from WVDP. The increase in costs for the Centralized Alternative is driven by the canisters at SRS (2,373), which have been shipped to the Hanford Site for follow-on storage before the geologic repository opens.

If the opening of the geologic repository is delayed past 2015, costs will increase $4 million for every year of additional storage required.

9.15 Environmental-Restoration-Transferred Waste

There is no environmental-restoration-transferred HLW.

No HLW will be generated during environmental restoration activities and, therefore, such waste is not considered in this analysis.

9.16 Comparison of Alternatives Summary

Health Risks. Both fatalities and cancer incidences for waste management workers are comparable for the Decentralized, Regionalized, and Centralized Alternatives and do not favor one alternative over another. Worker cancer fatalities from radiation exposure exceed fatalities from physical hazards. The Decentralized, Regionalized, and Centralized Alternatives each have three estimated cancer fatalities and one to two estimated fatalities from physical hazards. Truck transportation risks are slightly higher for the Centralized Alternative when the opening of a geologic repository is delayed than for other alternatives in the categories of radiological risks and physical trauma from traffic accidents. Fatalities from facility accidents are less than one for each of the HLW alternatives.

Air Quality Impacts. The management of HLW canisters would not appreciably affect the air quality at any site. No criteria air pollutants would exceed standards at any site. Emissions of hazardous air pollutants (including radionuclides) and toxic air pollutants from storage facilities, were assumed to be negligible.

Water Resources Impacts. Major impacts to water resources at all affected sites are unlikely even if the HLW repository does not begin to accept DOE-managed HLW in 2015 and extended storage of HLW canisters at the sites is required.

Ecological Resources Impacts. Loss of limited acreages of habitat at the DOE sites during construction of HLW canister storage facilities should not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. Operation of HLW canister storage facilities should not affect ecological resources because airborne emissions and liquid effluents are expected to be negligible. When specific HLW canister storage facility locations are proposed, DOE will conduct site- and project-level analyses to determine if any sensitive species, including Federally and State-listed endangered and threatened species, may be affected and will establish appropriate protection measures. DOE should be able to locate new HLW canister storage facilities to avoid impacts to nearby wetlands and other sensitive habitats, because construction site acreages are small compared to the total acreage at each site suitable for waste operations. Transportation accidents involving shipment of HLW canisters should be extremely rare and should not affect aquatic habitats because of the vitrified form of the HLW and special packaging.

Economic Impacts. HLW canister storage facility construction and operations expenditures would minimally benefit the local economy at the four HLW sites because estimated jobs and personal income are well below 1% of regional employment and income at all sites under all the alternatives. None of the HLW alternatives would affect the national economy, although 328 to 1,200 jobs would be directly or indirectly financed.

Population Impacts. The overall population in-migration remains relatively constant under all proposed alternatives and does not result in a major increase at any site. No corresponding changes to community characteristics or the provision of services would be anticipated; however, some impacts to the social environment are evident under all of the alternatives. The most serious concerns exist for the No Action Alternative, where existing limitations on HLW canister storage capability restrict canister production at the Hanford Site and INEL, and delay removal of untreated HLW from all sites; and for the Centralized Alternative, where the Hanford Site would receive large quantities of additional treated HLW for storage from other sites. Although the number of canisters received at the Hanford Site and SRS would be substantially lower in the Regionalized Alternatives, some public opposition to receipt of WVDP's HLW canisters could occur at these sites.

Environmental Justice Concerns. Assessment of potential environmental justice impacts from management of HLW canisters indicated that minority and low-income populations at the HLW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HLW alternatives.

Land Use Impacts. No impacts to current onsite or offsite land uses would result from implementing any of the HLW alternatives because for all the sites, land requirements to build HLW canister storage facilities are less than 1% designated or suitable lands. In addition, the proposed HLW canister storage facilities do not conflict with the development plans for any site.

Infrastructure Impacts. Proposed HLW activities show a potential for effects to onsite infrastructure only at the Hanford Site although the effects would be minor. No offsite infrastructure impacts are expected at any site. Estimated new requirements for wastewater treatment at the Hanford Site increase current demand in all alternatives, except No Action. Employment increases do not approach or exceed 5% of current site employment. Traffic increases would be minimal during construction, and would not affect onsite transportation infrastructure.

Cultural Resources Impacts. Construction and operation of HLW canister storage facilities could adversely affect cultural resources. Potential adverse effects at specific candidate construction locations will be considered in sitewide or project-level NEPA reviews.

Costs. The costs of HLW canister storage and transportation remain relatively stable at approximately $3 billion, for all alternatives except No Action. Costs do rise slightly when HLW canister storage is Centralized. Delay in disposing the waste at the geologic repository causes the life-cycle costs to increase at a rate of 0.2% per year of delay.

Summary of Impacts by Alternatives. Table 9.16–1 summarizes the key impacts for each HLW alternative.

The Preferred Alternative. The Department's preferred alternative at this time is to store its HLW where the waste is treated pending a decision on its disposal or other disposition. Because it is impractical to ship liquid HLW for treatment, the Department had previously decided that each of the four sites with HLW (Hanford, INEL, SRS, and WVDP) will treat its own waste onsite.

The potential impacts of DOE's preferred alternative are presented under the Decentralized Alternative for HLW. This alternative minimizes the transportation of treated HLW, makes use of existing storage capacity at WVDP and SRS, and would cost less than regionalized or centralized storage. The potential environmental impacts of all alternatives for HLW evaluated in the WM PEIS are small.

Table 9.16–1. Comparison of HLW Alternatives—Selected Impacts

Alternative	Number of Sites Storing	Worker Physical Hazard Fatalities	Worker Cancer Fatalities	Truck Radiation Fatalities	Truck Non-Radiation Fatalities	Truck Shipments	Cost ($ Billions)
No Action	4	1	2	3	2	20,000	1.5
Decentralized	4	1	3	3	2	22,000	2.7
Regionalized 1	3	1	3	3	2	22,000	2.7
Regionalized 2	3	2	3	3	2	22,000	2.7
Centralized	1	2	3	3	2	24,000	2.9

Note: * = greater than 0 but less than 0.5.

Chapter 9

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WSRC. *See* Westinghouse Savannah River Company.

High-Level Waste Alternatives

Alternative	Store	Hanford	INEL	SRS	WVDP
No Action	4	S	S	S	S
Decentralized	4	S	S	S	S
Regionalized 1	3	S	S	S	
Regionalized 2	3	S	S	S	
Centralized[a]	1	S			

Note: Blanks indicate that storage of HLW does not occur at a site under the alternative specified.

[a] Canisters generated at WVDP, SRS, and INEL prior to acceptance at the candidate repository in 2015 would be shipped to the Hanford Site for storage. Canisters generated at SRS and INEL after 2015 would be shipped directly to the candidate repository. If acceptance of the DOE-managed HLW is delayed past 2015, then all HLW canisters would be shipped to Hanford for storage.

CHAPTER 10
Impacts of the Management of Hazardous Waste

Chapter 10 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for hazardous waste (HW). This chapter provides information on existing HW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to HW characteristics, the treatment and disposal technologies considered, and the rationale for selecting the specific sites analyzed under each alternative. The chapter discusses the human health risks, environmental impacts, and costs of the alternatives, and provides a comparison of alternatives.

The methods used to evaluate the impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the HW analysis are contained in a technical report entitled "Hazardous Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports listed in Chapter 15.

10.1 Background

10.1.1 DEFINITION AND ORIGIN

- *HW is nonradioactive chemical waste.*
- *HW is generated as a result of research and development and as a byproduct of nuclear weapons production and dismantlement.*
- *HW is generated or exists at most DOE sites.*
- *Most nonwastewater DOE HW is treated commercially.*
- *DOE needs to decide whether to develop additional capacity of its own to treat HW.*

Hazardous waste consists of nonradioactive waste materials generated as a result of nuclear weapons production and other research and development activities. HW is any solid waste, not otherwise precluded from regulation under the Resource Conservation and Recovery Act (RCRA), that exhibits the characteristics of ignitability, corrosivity, reactivity, or toxicity, as defined by RCRA, or which has otherwise been determined to pose a hazard and which has been designated by the RCRA as a listed HW. RCRA defines a "solid" waste to include solid, semi-solid, liquid or contained gas (42 USC 6901).

In addition to HW as defined by RCRA, DOE manages some State-regulated HW and those wastes specified in the Toxic Substances Control Act (TSCA) (15 USC 2601). Special nuclear material and byproduct materials, as defined by the Atomic Energy Act, are specifically excluded from definition of wastes defined under RCRA.

Most DOE HW consists of wastewater that contains less than a 1% concentration of organic HW materials. Nonwastewater HW consists of sludges, solids and organic liquids (water containing higher concentrations of organic HW than wastewater). Wastewater HW is generated as a result of operations such as metal cleaning, etching and plating. DOE currently treats wastewater HW onsite and will continue to do so in the future because wastewater is not difficult to treat, but is difficult and not cost-effective to transport. Wastewater HW is treated to regulatory standards and released into the environment (EI, 1993).

The remainder of this chapter focuses on the nonwastewater HW. DOE currently ships most of this HW offsite to commercial facilities for treatment and disposal, and two sites (ORR and INEL) have the capability to treat nonwastewater HW thermally. DOE needs to decide the extent to which it should continue its reliance on the offsite treatment of nonwastewater HW.

In accordance with RCRA, the U.S. Environmental Protection Agency (EPA) has established requirements for managing HW:

- HW must be treated before land disposal and is subject to land disposal restrictions (LDRs) "best demonstrated available technology" (BDAT) requirements (e.g., thermal treatment units).
- HW storage is allowed only for a limited time to accumulate sufficient quantities for treatment.
- Disposal facilities must meet RCRA minimum technology requirements.

DOE must make decisions within the framework of these requirements to ensure that adequate treatment is available for HW. These decisions involve the location and construction of DOE facilities, and the extent to which the commercial HW facilities should be utilized for nonwastewater HW.

10.1.2 Volumes and Locations

HW has been generated, or is projected to be generated at most DOE sites. Naval Nuclear Propulsion Program sites identified in this document may generate HW. Their management of this waste type is not considered in this PEIS analysis, and they are not subject to associated decisions. Although HW generation from the production of nuclear weapons has essentially stopped, many chemicals and chemical residues were abandoned or left in containers and process lines. These wastes must be treated to comply with Federal and State hazardous waste regulations. The projected generation of HW from ongoing DOE research and development activities will include chemical wastes, organic solvents from incomplete chemical reactions, sludges from degreasing operations, and heavy metals from unrecycled batteries.

Based on RCRA uniform HW shipping manifests (40 CFR 262.20), facility reports, and HW generation and disposal information dating back to 1984, DOE estimates that more than 90% of the total HW (wastewater and nonwastewater) in a given year is generated by 11 or fewer of the 54 DOE sites, although these 11 sites are not always the same every year. Table 10.1-1 provides the quantities of HW at the 11 large HW generators used for the evaluation of the WM PEIS alternatives. Onsite treatment and storage tonnage was derived from 1991 data in biennial and annual reports (40 CFR 262.41). The offsite shipments to commercial treatment were derived from fiscal year 1992 shipping manifests, and include only RCRA-defined wastes. The focus of the WM PEIS alternatives is on the RCRA-defined waste shipped offsite and waste thermally treated[1] or used for fuel burning onsite—approximately 3,440 metric tons, almost all of which is nonwastewater (DOE[2]).

For purposes of this PEIS analysis, DOE assumed that these volumes of HW are representative of DOE's current HW treatment requirements. Of the 3,440 metric tons of HW sent from DOE sites to commercial facilities for treatment in FY 1992, about half of this amount was thermally treated. Another third was treated offsite to recover either solvents (distillation) or energy (phase separation and fuel blending), and the remainder was treated by stabilization, metal removal and recovery, deactivation, and aqueous treatment methods.

Analysis in the WM PEIS assumes use of existing and planned treatment facilities until their capacities are met. If additional capacity is needed, use of new conceptual DOE facilities or offsite commercial facilities is assumed. These new conceptual commercial facilities provide the difference in treatment capacity between the baseline (ANL, 1996) and what is necessary to manage the waste received under any given alternative. Conceptual treatment facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). An assumption was made that the impact of operating existing/planned facilities is essentially identical to the impact of operating conceptual facilities.

[1] The form of thermal treatment discussed in this chapter is incineration.

[2] DOE (1995; 1994a-e; 1993a,b; 1992a-c; 1987; 1982).

Table 10.1-1. HW at 11 Large DOE Generators[a]
(metric tons[b]/year)

DOE Site	Total Wastewater Treated Onsite[c]	Onsite Thermal Treatment and Fuel Burning[c]	Other Onsite Treatment and Storage[c]	Offsite Commercial Treatment[d]
ANL-E	0	0	2	206
Fermi	0	0	12	49
Hanford	0	0	140	302
INEL	33,000	35	80	160
KCP[e]	343,000	0	80	600
LANL	0	0	40	246
LLNL	250	0	230	629
ORR	624,000	66	14,600	207
Pantex	3,000	0	2,700	512
SNL-NM	130,000	0	0	153
SRS[e]	59,000	0	50	273
Total	1,192,250	101	17,934	3,337

[a] These sites represent the largest DOE HW generators for the time periods indicated. HW volumes generated vary annually among all sites, but these sites typically accounted for more than 90% of the DOE HW.
[b] Metric ton = 1,000 kilograms = 2,205 lb. One metric ton of HW is approximately one cubic meter in volume.
[c] Based on 1991 data taken from biennial and annual reports.
[d] Based on FY 1992 manifests. Includes only RCRA-defined waste; an additional 6,600 metric tons of TSCA, State-regulated HW, environmental restoration generated HW was shipped to commercial treatment in FY 1992.
[e] Excludes wastewater treatment of groundwater remediation waste reported in KCP and SRS biennial reports.

In addition to the RCRA-regulated HW shipped in FY 1992, 6,600 metric tons of TSCA, State-regulated HW, and HW generated as a result of environmental restoration activities were generated at DOE sites in 1992.[3] All of these wastes were sent offsite, with about one-third of these wastes sent to commercial facilities for treatment and the other two-thirds sent directly to RCRA and TSCA approved landfills for disposal.

[3] The extent to which the volume of HW generated as a result of environmental restoration activities could affect the WM PEIS analysis is discussed in Section 10.15.

10.2 Analytical Methods and Assumptions

10.2.1 CHARACTERISTICS

DOE HW can be categorized as RCRA-defined wastes, State-regulated waste, and TSCA-defined wastes. HW that is classified as RCRA waste is further categorized into three groups as shown in Table 10.2–1. The principal State-regulated wastes that DOE manages are waste oils and petroleum contaminated soils. The primary TSCA wastes managed by DOE are polychlorinated biphenyls (PCBs) and asbestos.

10.2.2 TECHNOLOGIES AND TREATMENT PROCESSES

Under RCRA, all HW must be treated to meet certain standards before the waste (or its treatment residues) may be placed on the land for final disposal. These treatment standards may be either concentration-based or technology-based. EPA regulations identify the treatment technologies that EPA recognizes as appropriate for HW. These technologies serve as the basis for DOE treatment technology groups. The nine major treatment technology groups, along with a brief description of each, are as follows:

Organic Destruction. Destruction of organic liquids and solids can be accomplished by a broad spectrum of technologies that include the following subgroups: incineration, other thermal technologies (e.g., metal melting, plasma torch), biological treatment, and chemical destruction. Besides neutralizing toxic organic constituents of the waste, organic destruction can significantly reduce the primary waste volume.

Table 10.2–1. Three Categories of RCRA Hazardous Waste

Listed Hazardous Wastes	Characteristic Hazardous Wastes	Other Hazardous Wastes
• Nonspecific sources • Specific sources • Commercial chemical products—acutely hazardous • Commercial chemical products—nonacutely hazardous	• Ignitable • Corrosive • Reactive • Toxic	• Mixtures (hazardous and nonhazardous) • Derived from wastes (treatment residues) • Materials containing listed hazardous wastes

Aqueous Treatment. This group incorporates a number of specialized treatment technologies. Examples include biological treatment, wet oxidation, and chemical oxidation/reduction. These technologies are often very specialized and waste specific. As such, they are generally not as readily available on a commercial basis as some of the other treatment technologies.

Deactivation/Neutralization. The technologies in this group refer to processes that remove the hazardous characteristics of a waste when these characteristics are based on ignitability, explosivity, corrosivity, and/or reactivity. Commercially, deactivation/neutralization is most commonly employed in the neutralization of corrosive wastes, while deactivation is also the preferred technology for most reactive wastes.

Organic Removal/Recovery. Along with incineration, organic removal/recovery is one of the most common forms of commercial treatment for organic liquids. This group encompasses a wide range of technologies including solvent recycling and distillation, fuel substitution (organic liquid hazardous wastes with high energy content are substituted for virgin fuels in industrial equipment permitted by EPA to burn hazardous waste fuel), carbon absorption, steam stripping, liquid-liquid extraction, and chemical/physical phase separation. Of the above, solvent distillation and fuel substitution are the most readily available on a commercial basis.

Metal Removal/Recovery. This technology group incorporates processes that are designed to remove and/or recover heavy metals present in RCRA wastes. The technologies most commonly used for metal removal/recovery include ion exchange, resin or solid adsorption, reverse osmosis, chelation/solvent extraction, ultrafiltration, and/or simple chemical precipitation. Some thermal processes may be used as well. Frequently, some form of physical phase separation or concentration techniques such as decantation, filtration and centrifugation are used in conjunction with the technologies noted above.

Mercury Recovery/Removal. As a technology group, mercury recovery/removal is actually a subset of the metal removal/recovery treatment technology group. From a practical standpoint, it is addressed separately because the commercial facilities that manage waste with high levels of mercury are usually very specialized. The actual technologies employed include amalgamation and recovery, mercury retorting, and thermal treatment with specialized control equipment.

Stabilization/Solidification. Stabilization and/or solidification refers to processes that tend to immobilize waste through chemical and/or physical means. Stabilization is one of the most common forms of treatment for inorganic wastes. Stabilization occurs when HW is mixed with a solidification agent such as Portland cement, fly ash, or cement kiln dust to form a solid. Stabilization generally requires a special design mix between the waste and the solidification agent to ensure that the concentration based LDRs standards are met. Stabilization is generally followed by land disposal at a HW landfill.

Recycling. Many of the technologies and technology groups described above incorporate some type of recycling (e.g., metal removal/recovery, organic removal/recovery, etc.). Recycling, in the context of the WM PEIS, refers to the use of materials that would otherwise be a hazardous waste as a direct substitute for raw materials. Most waste that meets these criteria would be exempt from regulation under RCRA although many States would require that a HW shipping manifest be used when the waste is transported.

Land Disposal. Though not an actual form of treatment and not evaluated in the WM PEIS alternatives, land disposal is included as a technology group and discussed here since some direct disposal of HW in permitted landfills still occurs. The types of HW that might be deposited directly into a landfill include newly identified wastes (wastes that have been identified since 1984) for which no treatment standards have been established (e.g., 25 newly identified Toxicity Characteristic Leaching Procedure organic wastes) and wastes that are covered by a variance under the LDRs.

10.2.3 WM PEIS ASSUMPTIONS: FACILITIES, TREATMENT, AND DISPOSAL

Key assumptions and considerations used in the WM PEIS to characterize HW, develop treatment alternatives, and analyze associated impacts include the following:

- Wastewater HW, previously buried or disposed HW, waste generated by environmental restoration activities, or waste generated as a result of decontamination operations are not part of the HW loads considered in the WM PEIS and are not included in the HW alternatives analysis.
- Wastewater HW will continue to be treated onsite at DOE facilities.
- Future HW generation rates are assumed to be the same as those identified in Table 10.1–1.
- Factors that could result in a decline in the quantities of HW (e.g., waste minimization efforts, reconfiguration of the DOE Nuclear Weapons Complex, reductions in generated HW from cancellation of DOE weapons programs) will not affect the analysis of the HW alternatives.

- Factors that could result in an increase in HW quantities (e.g., reclassification of low-level mixed waste (LLMW) or HW generated from the dismantlement of weapons) will not affect the analysis of the HW alternatives.
- Since onsite storage of HW is limited under RCRA to 90 days without a RCRA Part B permit, HW inventories will not accumulate at generator sites.
- The estimated cost associated with the commercial treatment of HW assumes that the treated residue is disposed of in compliance with applicable Federal and State LDRs.

10.3 Hazardous Waste Alternatives

The WM PEIS HW analysis considers four alternatives for treatment facilities within the broad categories of management alternatives: No Action, Decentralized, and two Regionalized. The alternatives were selected to provide representative results for the range of onsite options. Thus, the alternatives evaluate 3%, 9%, 50%, and 90% of the DOE RCRA waste (excluding wastewater) being treated onsite. The Centralized Alternative for the management of HW was not considered a prudent alternative from the standpoint of cost, health risk, and environmental or socioeconomic impacts and from the standpoint of a number of practical considerations, such as the significant amount of transportation that would be required even under the best waste minimization programs. The foldout table at the end of this chapter shows the sites at which HW would be treated under each alternative. The table is designed to be used as a quick reference when reading the HW impact sections.

Each of the alternatives was developed in order to capture and quantify the human health risks, environmental impacts, and costs associated with the range of HW treatment options available to DOE and to provide input for a decision about whether to continue to rely on offsite treatment of HW.

Public and worker risks and environmental impacts were not analyzed quantitatively for commercial treatment facilities for all four alternatives. Each of those facilities has obtained its own RCRA permit, which involved separate risk assessments done in support of the permitting process. In addition, the DOE portion of the annual waste processed by those facilities is less than 5% per year.

10.3.1 No Action Alternative

Under this alternative, the current operations would be maintained. HW that is currently being treated onsite at DOE facilities (e.g., incineration of organic materials at ORR and INEL) will continue to be treated onsite, and other HW will continue to be treated offsite at commercial facilities. Figure 10.3–1 and Table 10.3–1 illustrate the No Action Alternative.

HW No Action Alternative (Treatment of 3% of Nonwastewater HW at 2 Sites; 97% at Commercial Facilities)

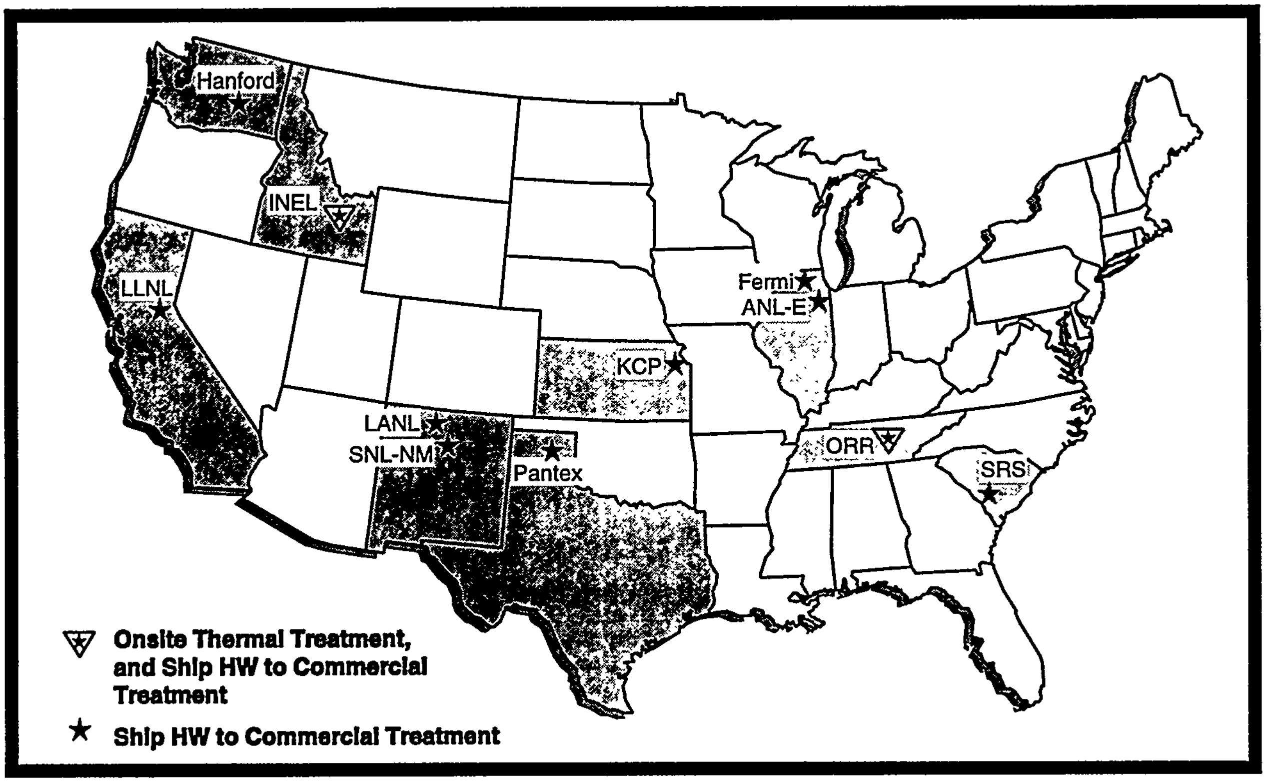

Figure 10.3–1. HW No Action Alternative

	Generating Sites		
	INEL	ORR	ANL-E, Fermi, Hanford, INEL, KCP, LANL, LLNL, ORR, Pantex, SNL-NM, SRS
Treat	INEL	ORR	Commercial treatment

Table 10.3–1. HW No Action Alternative

10.3.2 DECENTRALIZED ALTERNATIVE

Under this alternative, DOE would implement thermal treatment at the Idaho National Engineering Laboratory (INEL), the Oak Ridge Reservation (ORR), and the Savannah River Site (SRS). DOE modified the Decentralized Alternative to replace LANL with INEL as a candidate site for onsite treatment of HW. This change reflects the fact that INEL currently has thermal HW treatment capacity, while LANL does not. In addition, the use of commercial facilities would continue as needed, with greater DOE controls on the number of facilities used, the services provided, and the performance delivered. The use of brokers, companies that consolidate HW from more than one customer to reduce storage and improve the economics of shipping, would be reduced. Brokering of HW usually increases total transport miles to get a waste package from the generator to the facility site because the packages are frequently brought to a collection site to be sorted and combined with similar packages for shipment to a facility location.

The main difference between the No Action and Decentralized Alternatives is a 6% shift in the waste totals for thermal treatment and fuel substitution from offsite treatment (No Action) to onsite treatment (Decentralized). Because of this relatively small difference, the No Action and Decentralized Alternatives are discussed together.

The waste management strategy for the No Action and Decentralized Alternatives can be summarized as follows:

- Package HW and ship it to commercial treatment facilities.
- Maintain and operate existing and planned DOE HW storage facilities and limited treatment facilities at DOE sites in accordance with applicable permit requirements for treatment facilities.
- Minimize generation of HW to the greatest extent possible.
- The Decentralized Alternative would involve thermal treatment at three sites (INEL, SRS, and ORR).

Figure 10.3–2 illustrates the Decentralized Alternative. Table 10.3–2 shows that most of the HW loads at the major HW sites would be transferred to commercial facilities. Except for wastes to be thermally treated or treated through fuel burning at INEL, ORR, and SRS, most wastes generated by the other major sites would also be sent to commercial facilities. The change of use in facilities between the No Action and Decentralized Alternatives is summarized in Table 10.3–3. The total net change in going from the No Action to the Decentralized Alternatives would be an increase of approximately 180 metric tons/yr in thermal treatment and 43 metric tons/yr in onsite fuel burning.

HW Decentralized Alternative (Treatment of 9% of Nonwastewater HW at 3 DOE Sites; 91% at Commercial Facilities)

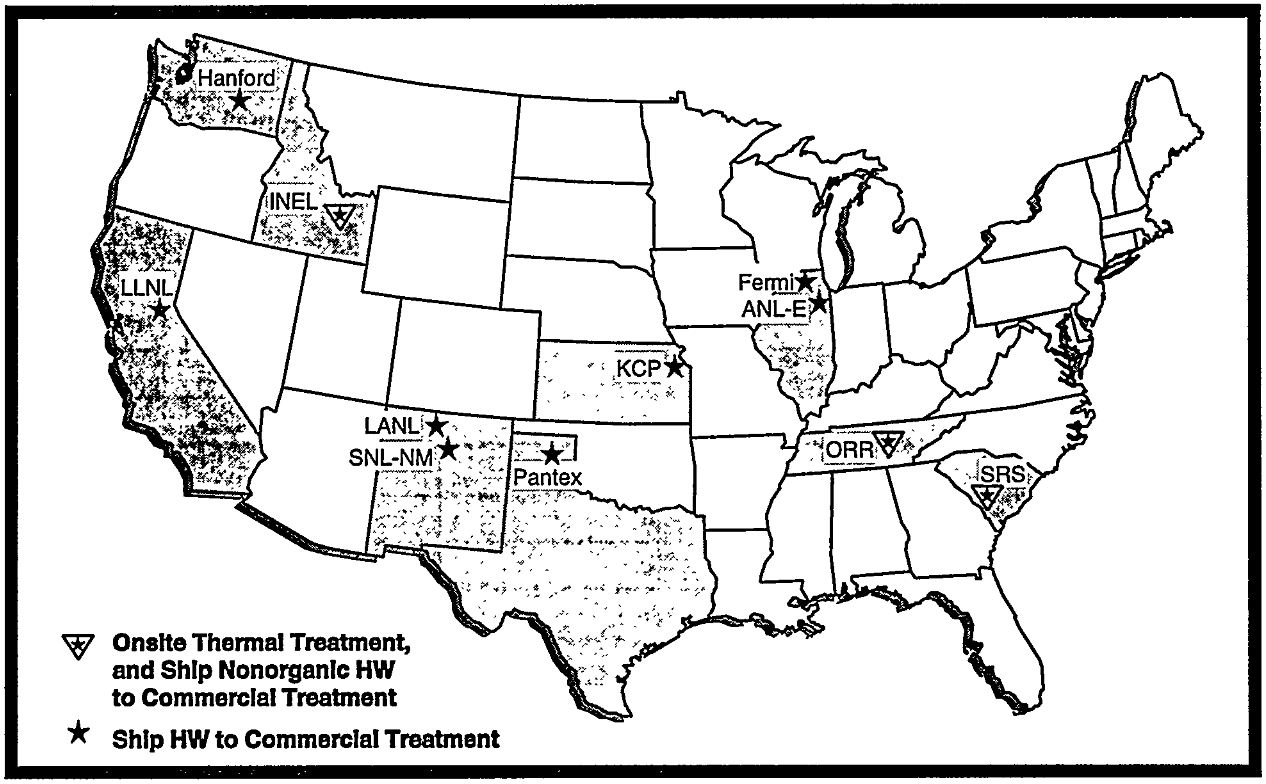

Figure 10.3–2. HW Decentralized Alternative

	Generating Sites			
	INEL	ORR	SRS	ANL-E, Fermi, Hanford, INEL, KCP, LANL, LLNL, ORR, Pantex, SNL-NM, SRS
Treat	INEL	ORR	SRS	Commercial treatment

Table 10.3–2. HW Decentralized Alternative

Table 10.3-3. Change in Use of Onsite Thermal Destruction and Waste-Fuel Burning Under No Action and Decentralized Alternatives

Site and Treatment	HW Treated by Thermal Destruction and Fuel Burning (metric tons/year)	
	No Action Alternative	**Decentralized Alternative**
INEL		
Thermal treatment	17.4	17.4
Fuel burning	17.4	17.4
ORR		
Thermal treatment	53.203	116.6
Fuel burning	12.6	27.7
SRS		
Thermal treatment	0	116.6
Fuel burning	0	27.7
Total		
Thermal treatment	70.6	250.6
Fuel burning	30.0	72.8

Tables 10.3-4 and 10.3-5 depict the No Action and Decentralized Alternatives in terms of HW treatment by treatment technology group for the major DOE HW sites. The treatment technology group of Organic Removal/Recovery involves three types of treatments: fuel blending, fuel burning, and solvent recycling. Because HW treated by fuel blending is ultimately burned, the amounts for fuel blending are included in the fuel burning row. The totals for treatment at commercial facilities are based on the overall amounts shipped offsite for FY 1992.

10.3.3 Regionalized Alternatives

Under Regionalized Alternative 1, half of the HW generated by 11 major HW sites would be retained and treated at five onsite DOE treatment centers or hubs: Hanford, INEL, LANL, ORR, and SRS. Each regional hub would be permitted under RCRA and onsite treatment facilities would be constructed for thermal treatment and organic removal/recovery. Figure 10.3-3 and Table 10.3-6 illustrate Regionalized Alternative 1.

Table 10.3-4. No Action Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)

Site	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ANL-E											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	72.0	0	0	1.2	19.0	20.0	3.4	90.0	0	0	205.6
Site total	**72.0**	**NA**	**0**	**1.2**	**19.0**	**20.0**	**3.4**	**90.0**	**0**	**0**	**205.6**
Fermi											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	28.0	0	0	10.6	2.2	7.5	0.1	0.6	0	0	49.0
Site total	**28.0**	**NA**	**0**	**10.6**	**2.2**	**7.5**	**0.1**	**0.6**	**0**	**0**	**49.0**
Hanford											
Onsite	0	0	0	0	0	0	0	0	0[e]	0	0
Commercial	22.0	0	151.8	78.2	3.0	45.0	0.1	1.5	0[e]	0.7	302.3
Site total	**22.0**	**NA**	**151.8**	**78.2**	**3.0**	**45.0**	**0.1**	**1.5**	**0[e]**	**0.7**	**302.3**
INEL											
Onsite	17.4	30.5	17.4	0	0	0	0	0	0	0	34.8
Commercial	93.5	0	13.1	15.7	9.3	15.0	7.4	1.7	3.7	0.5	159.9
Site total	**110.9**	**NA**	**30.5**	**15.7**	**9.3**	**15.0**	**7.4**	**1.7**	**3.7**	**0.5**	**194.7**
KCP											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	380.0	0	70.0	35.0	50.0	12.0	50.0	2.5	1.0	0	600.5
Site total	**380.0**	**NA**	**70.0**	**35.0**	**50.0**	**12.0**	**50.0**	**2.5**	**1.0**	**0**	**600.5**
LANL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	48.0	110.0	110.0	56.4	11.0	13.5	2.0	4.0	0	0.7	245.6
Site total	**48.0**	**NA**	**110.0**	**56.4**	**11.0**	**13.5**	**2.0**	**4.0**	**0**	**0.7**	**245.6**
LLNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	268.0	0	160.3	82.7	57.0	1.2	5.3	4.3	48.0	2.0	628.8
Site total	**268.0**	**NA**	**160.3**	**82.7**	**57.0**	**1.2**	**5.3**	**4.3**	**48.0**	**2.0**	**628.8**

Table 10.3–4. No Action Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)—Continued

Site	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ORR											
Onsite	53.2	42.7	12.6	0	0	0	0	0	0	0	65.8
Commercial	102.3	0	30.1	22.8	13.0	20.8	10.4	2.3	5.0	0.7	207.4
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Pantex											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	319.0	0	0	26.0	60.0	106.1	0	0.6	0	0	511.7
Site total	**319.0**	**NA**	**0**	**26.0**	**60.0**	**106.1**	**0**	**0.6**	**0**	**0**	**511.7**
SNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	93.0	0	0	17.0	24.0	11.0	5.5	0.9	0	1.5	152.9
Site total	**93.0**	**NA**	**0**	**17.0**	**24.0**	**11.0**	**5.5**	**0.9**	**0**	**1.5**	**152.9**
SRS[d]											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	155.5	42.7	42.7	22.8	13.0	20.8	10.4	2.3	0.5	0.7	273.2
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**0.5**	**0.7**	**273.2**
Total											
Onsite	70.6	NA	30.0	0	0	0	0	0	0	0	100.6
Commercial	1,581.3	NA	578	368.4	261.5	272.9	94.6	110.7	62.7	6.8	3,336.9
Site Total	**1,651.9**	**NA**	**608**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3,437.5**

Notes: Hg = mercury; NA = not applicable.
[a] Assumes that this technology was the appropriate technology for 1992 amounts incinerated. Much of this waste could have gone to removal and recovery of organics or was corrosive and could have been deactivated.
[b] The amount blended was not counted in the total waste amount generation; amount was counted when burned as fuel.
[c] At each location, some of these solvents (approximately 10%) were also recycled by Safety-Kleen.
[d] Waste amounts were derived from manifests. Because of the moratorium, the precise amount of actual waste generated cannot be determined at this time. For this table, amounts for SRS are assumed to be the same as those for ORR.

Table 10.3–5. Decentralized Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)

Site and Location of HW Treatment	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ANL-E											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	72.0	0	0	1.2	19.0	20.0	3.4	90.0	0	0	205.6
Site total	**72.0**	**NA**	**0**	**1.2**	**19.0**	**20.0**	**3.4**	**90.0**	**0**	**0**	**205.6**
Fermi											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	28.0	0	0	10.6	2.2	7.5	0.1	0.6	0	0	49.0
Site total	**28.0**	**NA**	**0**	**10.6**	**2.2**	**7.5**	**0.1**	**0.6**	**0**	**0**	**49.0**
Hanford											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	22.0	0	151.8	78.2	3.0	45.0	0.1	1.5	0	0.7	302.3
Site total	**22.0**	**NA**	**151.8**	**78.2**	**3.0**	**45.0**	**0.1**	**1.5**	**0**	**0.7**	**302.3**
INEL											
Onsite	17.4	0	17.4	0	0	0	0	0	0	0	34.8
Commercial	93.5	0	13.1	15.7	9.3	15.0	7.4	1.7	3.7	0.5	159.9
Site total	**110.9**	**NA**	**30.5**	**15.7**	**9.3**	**15.0**	**7.4**	**1.7**	**3.7**	**0.5**	**194.7**
KCP											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	380.0	0	70.0	35.0	50.0	12.0	50.0	2.5	1.0	0	600.5
Site total	**380.0**	**NA**	**70.0**	**35.0**	**50.0**	**12.0**	**50.0**	**2.5**	**1.0**	**0**	**600.5**
LANL											
Onsite	0[d]	0	0	0	0		0	0	0	0	0
Commercial	48.0	110.0	110.0	56.4	11.0	13.5	2.0	4.0	0	0.7	245.6
Site total	**48.0**	**NA**	**110.0**	**56.4**	**11.0**	**13.5**	**2.0**	**4.0**	**0**	**0.7**	**245.6**
LLNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	268.0	0	160.3	82.7	57.0	1.2	5.3	4.3	48.0	2.0	628.8
Site total	**268.0**	**NA**	**160.3**	**82.7**	**57.0**	**1.2**	**5.3**	**4.3**	**48.0**	**2.0**	**628.8**

Table 10.3-5. Decentralized Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)—Continued

Site	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ORR											
Onsite	116.6[e]	42.7	27.7	0	0	0	0	0	0	0	144.3
Commercial	38.9	0	15.0	22.8	13.0	20.8[e]	10.4	2.3	5.0	0.7	128.9
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Pantex											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	319.0	0	0	26.0	60.0	106.1	0	0.6	0	0	511.7
Site total	**319.0**	**NA**	**0**	**26.0**	**60.0**	**106.1**	**0**	**0.6**	**0**	**0**	**511.7**
SNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	93.0	0	0	17.0	24.0	11.0	5.5	0.9	0	1.5	152.9
Site total	**93.0**	**NA**	**0**	**17.0**	**24.0**	**11.0**	**5.5**	**0.9**	**0**	**1.5**	**152.9**
SRS[f]											
Onsite	116.6[e]	42.7	27.7	0	0	0	0	0	0	0	144.3
Commercial	38.9	0	15.0	22.8	13.0	20.9	10.4	2.3	5.0	0.7	128.9
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.9**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Total											
Onsite	250.6	NA	72.8	0	0	0	0	0	0	0	323.4
Commercial	1,401.3	NA	535.2	368.4	261.5	272.9	94.6	110.7	62.7	6.8	3,114.1
Total	**1,651.9**	**NA**	**608**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3,437.5**

Notes: Hg = mercury; NA = not applicable.

[a] Assumes that this technology was the appropriate technology for 1992 amounts thermally treated. Much of this waste could have gone to removal and recovery of organics or was corrosive and could have been deactivated.

[b] The amount blended was not counted in the total waste amount generation; amount was counted when burned as fuel.

[c] At each location, some of these solvents (assuming approximately 10%) were also recycled by Safety-Kleen.

[d] Assumes onsite thermal treatment can destroy 50% of generated liquid HW that can be thermally treated.

[e] Assumes that onsite thermal treatment at ORR and SRS can destroy 75% of generated liquid HW that can be thermally treated.

[f] Waste amounts were derived from manifests. The precise amount of actual waste generated cannot be determined at this time. For this table, amounts for SRS are assumed to be the same as those for ORR.

HW Regionalized Alternative 1 (Treatment of 50% of Nonwastewater HW at 5 DOE Sites; 50% at Commercial Facilities)

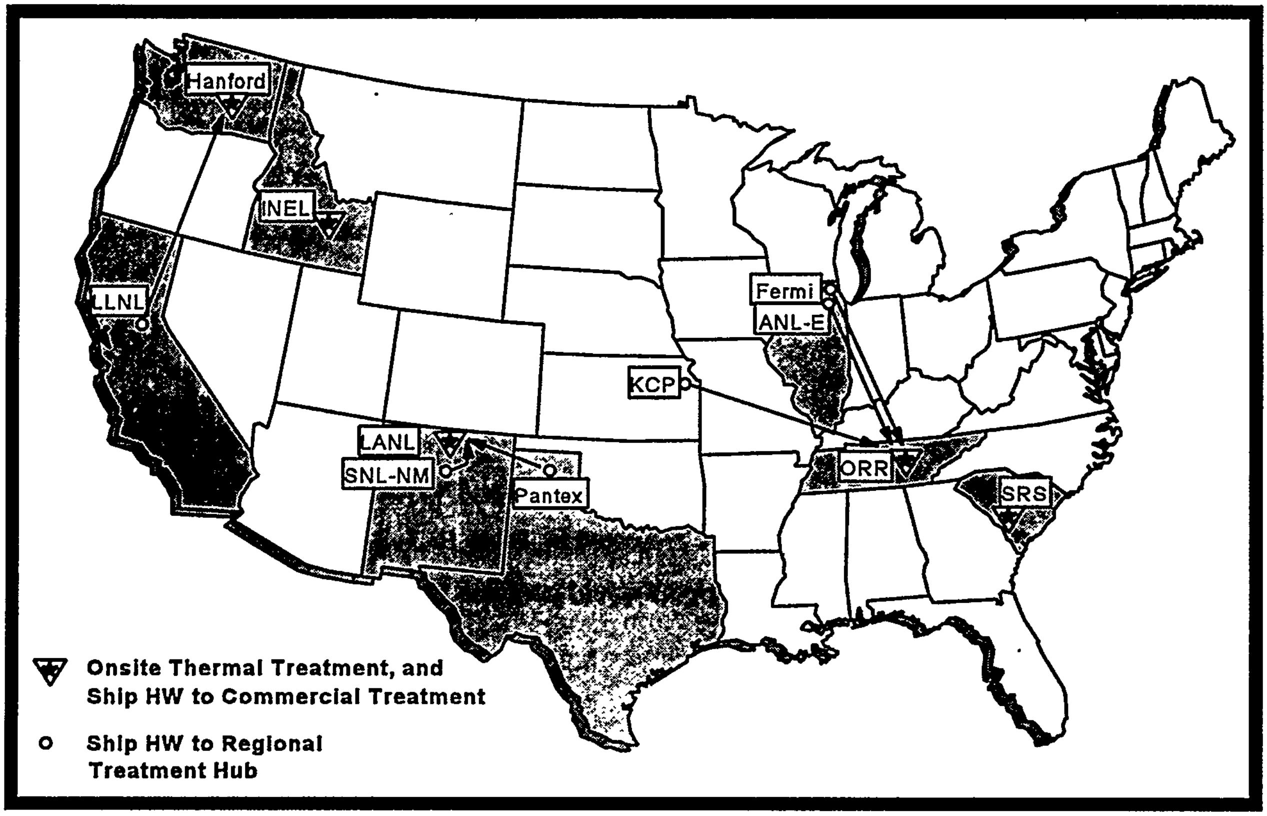

Figure 10.3–3. HW Regionalized Alternative 1

	Generating Sites					
	Hanford, LLNL	INEL	LANL, Pantex, SNL-NM	ANL-E, Fermi, KCP, ORR	SRS	Hanford, INEL, LANL, ORR, SRS
Treat	Hanford	INEL	LANL	ORR	SRS	Commercial treatment

Table 10.3–6. HW Regionalized Alternative 1

Data for Regionalized Alternative 1 are presented in Table 10.3–7. Under this alternative, HW that could be treated through the organic removal/recovery technologies would be sent to five regional hub sites from the major generating sites. The hub sites would treat two-thirds of the received HW and send the other one-third to commercial facilities. For HW that could be treated through thermal treatment, two-thirds would be sent to the regional hubs from the generating sites, and the other third would be sent directly to commercial thermal treatment facilities from the generating sites. The amounts of HW to be treated by the various treatment technology groups at the regional hubs and associated commercial facilities are shown in the table. Approximately 50% of the estimated 3,437 metric tons of HW listed in Table 10.3–7 would be treated at DOE HW facilities.

Under Regionalized Alternative 2, DOE would build facilities at INEL and ORR for organic treatment and deactivation/neutralization. Figure 10.3–4 illustrates Regionalized Alternative 2. All HW treatable in these facilities would be shipped from the other sites presented in Table 10.3–8. Metal recovery and recycling, battery recycling, stabilization, and land disposal would continue to be provided by offsite commercial establishments.

Under Regionalized Alternative 2, all deactivation waste would be treated at the appropriate hub, with INEL the only hub expected to receive such waste. The Pantex Plant, LANL, LLNL, the Sandia National Laboratories-New Mexico (SNL-NM) and the Nevada Test Site (NTS) would ship to INEL for thermal deactivation. Approximately 90% or 3,058 metric tons of HW listed in Table 10.3–9 would be treated at DOE HW facilities.

10.3.4 Centralized Alternative

A single site Centralized Alternative for the management of HW was not considered in this PEIS because the DOE decision of concern is whether DOE should continue to use commercial facilities for the treatment and disposal of HW, or construct its own facilities. Current policy is the decentralized or regionalized use of commercial facilities. This PEIS seeks to compare decentralization and regionalization of proposed DOE facilities to the current HW practices.

Table 10.3-7. Regionalized Alternative 1: HW Treatment for 11 Large DOE HW Sites (in metric tons)

Hub	Organic Destruction by Thermal Treatment[a]	Organic Removal/Recovery[b]			Stabilization	Deactivation	Metal Removal/ Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
Hanford Hub (Hanford; LLNL)											
Onsite	191.5	(312.0)[d]	206.0	106.0	0	0	0	0	0	0	503.5
Commercial	98.5	0	106.1	54.9	60.0	46.2	5.4	5.8	48.0	2.7	427.6
Hub total	290.0	NA	312.1	160.9	60.0	46.2	5.4	5.8	48.0	2.7	931.1
INEL Hub (INEL)											
Onsite	73.2	(30.5)[d]	30.5	0	0	0	0	0	0	0	103.7
Commercial	37.7	0	0	15.7	9.3	15.0	7.4	1.7	3.7	0.5	91.0
Hub total	110.9	NA	30.5	15.7	9.3	15.0	7.4	1.7	3.7	0.5	194.7
Los Alamos Hub (LANL; SNL; Pantex)											
Onsite	303.6	(137.6)[d]	73.3	66.3	0	0	0	0	0	0	443.2
Commercial	156.4	0	36.7	33.1	95.0	130.6	7.5	5.5	0	2.2	467.0
Hub total	460.0	NA	110.0	99.4	95.0	130.6	7.5	5.5	0	2.2	910.2
Oak Ridge Hub (ORR; Fermi; KCP; ANL-E)											
Onsite	420.0	(120.4)[d]	75.1	46.4	0	0	0	0	0	0	538.8
Commercial	215.5	0	37.6	23.2	84.2	60.3	63.9	95.4	6.0	0.7	589.5
Hub total	635.5	NA	112.7	69.6	84.2	60.3	63.9	95.4	6.0	0.7	1,128.3
Savannah Hub (SRS)											
Onsite	102.6	(42.7)[d]	28.0	15.0	0	0	5.2	0	0	0	150.8
Commercial	52.9	0	14.7	7.8	13.0	20.8	5.2	2.3	5.0	0.7	122.4
Hub total	155.5	NA	42.7	22.8	13.0	20.8	10.4	2.3	5.0	0.7	273.2
Total											
Onsite	1,090.9	(643.2)[d]	412.9	233.7	0	0	5.2	0	0	0	1,738.1
Commercial	560.9	(0)	195.1	134.7	261.5	272.9	89.5	110.7	62.7	6.8	1,698.2
Total	1651.9	NA	608	368.4	261.5	272.9	94.6	110.7	62.7	6.8	3437.5

Notes: Hg = mercury; NA = not applicable.

[a] Assumes that 2/3 of all material that can be thermally treated is thermally treated at regional hub and 1/3 at commercial facilities.

[b] Assumes that 2/3 of removal and recovery of organics is conducted onsite at regional hub and 1/3 at commercial facilities.

[c] Some of these solvents (approximately 10%) are also recycled by Safety-Kleen at each individual site location.

[d] This amount was not counted on overall treatment totals when blended. Rather, amount was counted when burned as fuel.

HW Regionalized Alternative 2 (Treatment of 90% of Nonwastewater HW at 2 DOE Sites; 10% at Commercial Facilities)

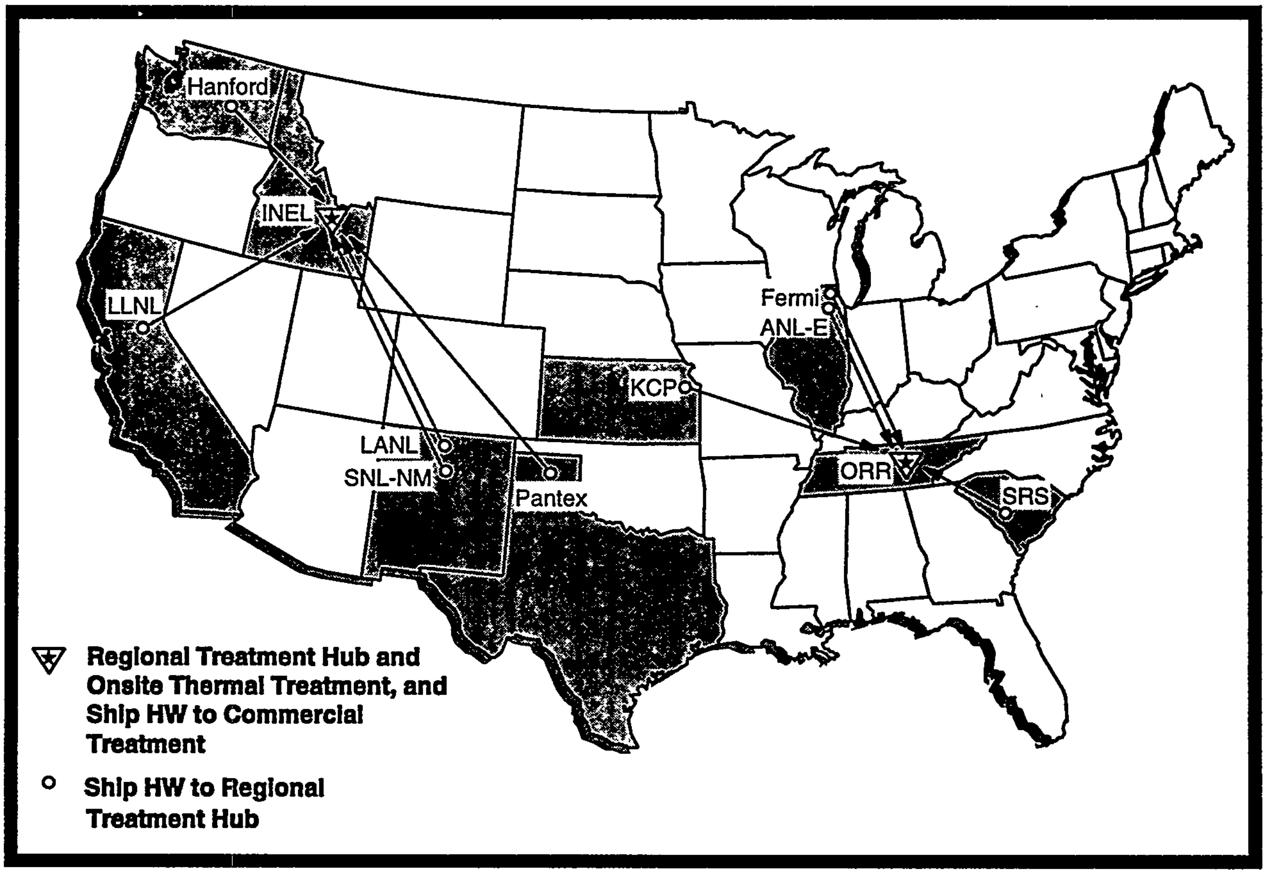

Figure 10.3–4. HW Regionalized Alternative 2

	Generating Sites		
	Hanford, INEL, LANL, LLNL, Pantex, SNL-NM	ANL-E, Fermi, KCP, ORR, SRS	INEL, ORR
Treat	INEL	ORR	Commercial treatment

Table 10.3–8. HW Regionalized Alternative 2

Table 10.3-9. Regionalized Alternative 2: HW Treatment for 11 Large HW Sites (in metric tons)

Hub and Location of HW Treatment	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending	Fuel Burning	Solvent Recycling[b]			Non-Hg	Hg			
INEL Hub (western region) (Hanford; INEL; LLNL; LANL; SNL-NM; Pantex)											
Onsite	860.9	(445.0)[c]	452.6	276.0	0	191.8	20.3	0	51.7	0	1,853.3
Commercial	0	0	0	0	164.3	0	0	13.0	0	5.4	182.7
Hub total	**860.9**	**NA**	**452.6**	**276.0**	**164.3**	**191.8**	**20.3**	**13.0**	**51.7**	**5.4**	**2,036.0**
ORR Hub (eastern region) (KCP; Fermi; ANL-E; SRS; ORR)											
Onsite	791.0	(163.0)[c]	155.4	92.4	0	81.1	74.3	0	11.0	0	1,205.2
Commercial	0	0	0	0	97.2	0	0	97.7	0	1.4	196.3
Hub total	**791.0**	**NA**	**155.4**	**92.4**	**97.2**	**81.1**	**74.3**	**97.7**	**11.0**	**1.4**	**1,401.5**
Total											
Onsite	1,651.9	(608.0)[c]	608.0	368.4	0	272.9	94.6	0	62.7	0	3,058.5
Commercial	0	(0)	0	0	261.5	0	0	110.7	0	6.8	379.0
Total	**1,651.9**	**NA**	**608.0**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3,437.5**

Notes: Hg = mercury; NA = not applicable.
[a] In some cases, attaining 90% onsite treatment without conducting stabilization and land disposal may not be possible.
[b] Some solvents (approximately 10%) would still be handled on a decentralized basis through Safety-Kleen.
[c] This amount is only counted in total when burnt as fuel.

The Regionalized 2 Alternative includes waste treatment using two sites, one east and one west of the Mississippi River. These locations are reasonable locations considering that DOE sites are spread throughout the continental United States. Treatment at two sites would lead to risk and cost reductions over using a single U.S. site.

10.3.5 Rationale for Selection of Sites

The HW treatment alternatives were selected to cover the range of reasonable alternatives based on two primary criteria: (1) site experience with key HW treatment technologies, and (2) location of sites. As in the case of evaluating alternatives for the management of the radioactive waste types, consideration was given to avoiding the introduction of HW to DOE sites for treatment that do not generate HW. These criteria and considerations serve to minimize the costs and impacts associated with the alternatives and sites selected.

The technologies evaluated for onsite treatment of HW are thermal treatment, fuel burning, and deactivation. Five of the sites listed in Table 10.3–1 for the No Action Alternative (current HW management approach)—the Hanford Site, INEL, LANL, ORR, and SRS—have operated or plan to operate thermal treatment systems.

Regionalized Alternative 1 uses the five DOE sites with the operational or planned thermal treatment systems satisfying the criterion for site technology experience. The location criterion is addressed in that the five sites are somewhat regionally distributed which serves to minimize transportation of HW and associated risks.

Regionalized Alternative 2 is based on using two sites for HW treatment. The two sites proposed, INEL and ORR, satisfy the technology experience criterion since they are among the five sites discussed above, and their locations (west and east in the United States) require the least transportation of HW compared to other site combinations. Onsite deactivation, or neutralizing, also considered in this alternative, is planned for the two hub-sites.

In calculating the mileage traveled in each HW alternative, the mileage to commercial facilities was included along with the mileage to DOE hub facilities. In this way, total mileage is calculated from the shipper to the location where final treatment takes place. A set of commercial facilities was chosen to represent the most probable choices of commercial facilities nearby, considering the types of waste needing treatment at the various DOE facilities.

10.4 Health Risks

The health risk estimates include a fraction of a single fatality for each of the proposed HW alternatives from vehicle accidents associated with HW transportation. The Regionalized Alternatives result in greater worker exposure to HW chemicals than the No Action and Decentralized Alternatives because DOE treats more HW under the Regionalized Alternatives. This analysis did not evaluate the risk to workers at commercial facilities which are the principal HW treatment facilities under the No Action and Decentralized Alternatives. It is expected that HW worker risks would be the same regardless of whether commercial or DOE facilities are used. In view of this, there is no significant difference between the alternatives with regard to HW worker risk.

Health risk impacts can result from exposure to hazardous chemicals and from physical trauma associated with constructing and operating treatment facilities or transporting waste. This section discusses the estimated adverse health impacts resulting from chemical exposure as well as the physical hazards for each HW treatment alternative. Details of the HW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5 and in ORNL technical reports (ORNL, 1995a-c). Potential health risks to a number of receptor populations and individuals are reported including:

- The offsite population—those individuals living within a 50-mile radius of the site, as well as along transportation routes
- Noninvolved workers population—the workers on DOE sites who are not involved directly in waste management activities.
- Waste management worker population (or "waste management workers")—onsite employees working in a site's waste management facilities, including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and

trains that transport the waste. Although DOE treats more of its HW under the Regionalized Alternatives, whereas commercial HW treatment facilities are used under the No Action and Decentralized Alternatives, worker risk is assumed to be similar whether HW treatment is conducted at a DOE or a commercial facility.

10.4 Health Risks
10.5 Air Quality Impacts
10.6 Water Resources Impacts
10.7 Ecological Resources Impacts
10.8 Economic Impacts
10.9 Population Impacts
10.10 Environmental Justice Concerns
10.11 Land Use Impacts
10.12 Infrastructure Impacts
10.13 Cultural Resources Impacts
10.14 Costs
10.15 Environmental Restoration Analysis
10.16 Comparison of Alternatives Summary

- Maximally exposed individual (MEI) for the offsite population—hypothetical individual in the offsite population who would receive the highest total lifetime multimedia dose
- MEI for the noninvolved worker population—hypothetical individual in the noninvolved worker population who would receive the highest total lifetime multimedia dose.
- A most-exposed waste management worker— an individual who would experience potential noncancer effects, as estimated using the Exposure Index, following exposure to HW.
- The human health and environmental impacts at and surrounding the commercial facilities involved in hazardous waste treatment were not considered quantitatively in this WM PEIS. Each of those facilities has obtained its own RCRA permit, which involved separate risk assessments done in support of the permitting process. In addition, the DOE portion of the annual waste processed by those facilities is less than 5% per year.

Maximally Exposed Individual

In keeping with standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week, for the 10-year period of treatment operations analyzed in the WM PEIS.

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer incidence from chemical exposure
- Noncancer effects from chemical exposure (for example, headaches, nasal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and developmental toxicity)

Interpreting the results of health risk analyses involves consideration of both uncertainties and appropriate standards. See Section 5.4.1 and Appendix D for a further discussion of these issues.

10.4.1 ROUTINE OPERATION IMPACTS

For operations involving HW treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in HW treatment ("noninvolved workers"), and waste management workers directly involved in treatment activities. Impacts were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts. Table 10.4–1 presents the sizes of offsite populations and waste management treatment worker populations used in the health risk analysis.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented.

Individual impacts focus on the *probability* that the "maximally exposed individual" (MEI) within each receptor population would experience an adverse health impact. Because the focus is on the MEI, the risk

Table 10.4–1. Offsite and Waste Management Treatment Worker Populations

Site	Offsite Population[a]	WM Treatment Worker Population by Alternative[b]			
		No Action	Decentralized	Regionalized 1	Regionalized 2
Hanford	377,645	--	--	91	--
INEL	153,061	16	16	35	160
LANL	159,152	--	--	88	--
ORR	881,652	36	36	101	212
SRS	620,618	--	--	40	--

Note: -- = no waste treatment at this site under this alternative.
[a] Within 50-mile radius of sites.
[b] Waste management worker population estimates represent full-time equivalents (FTEs) over the entire construction and operation periods.

is presented as a probability (e.g., one in one million, or 1E–06) of that individual experiencing an adverse health impact, rather than the total number of impacts for a selected population.

DOE analyzed the potential effects of exposure to hazardous chemicals on the receptor groups. The pathways of exposure analyzed were inhalation of contaminated air and ingestion of contaminated plants and animals.

Worker risks associated with physical hazards were evaluated for 20 years: a 10-year period of construction of treatment facilities, and a subsequent 10-year period of operation. However, worker and public risks from exposure to chemicals (received during the 10-year operation period) were evaluated for an entire lifetime (70 years), because health impacts from airborne contaminants could occur throughout the lifetime of the exposed individual.

Table 10.4–2 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for HW treatment.

Table 10.4–2. HW Health Risk Analysis Components

Endpoints	Receptor	Source	Pathways	Exposure Period	Table References
Number of Trauma Fatalities	WM Workers	Physical Hazards	Physical Hazards	20 years	Text only
Number of Cancer Incidences	Offsite Population	Chemicals	Inhalation, Ingestion	10 years	10.4–3
	Noninvolved Workers		Inhalation		
	WM Workers		Inhalation		
Probability of Cancer Incidence	Offsite MEI	Chemicals	Inhalation, Ingestion	10 years	10.4–4
	Noninvolved Worker MEI		Inhalation		
Noncancer Risk	Offsite MEI	Chemicals	Inhalation, Ingestion	10 years	10.4–5
	Noninvolved Worker MEI		Inhalation		
	WM Worker		Inhalation		

Understanding Scientific Notation

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10	Negative Powers of 10
$10^1 = 10 \times 1 = 10$	$10^{-1} = 1/10 = 0.1$
$10^2 = 10 \times 10 = 100$	$10^{-2} = 1/100 = 0.01$
and so on; therefore,	*and so on; therefore,*
$10^6 = 1,000,000$ *(or 1 million)*	$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.	*etc.*

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^5 *can also be written as 3.0E+05, and* 3×10^{-5} *is equivalent to 3.0E–05. Therefore, 3.0E+05 = 300,000 and 3.0E–05 = 0.00003.*

The health risk data tables in this section use "E" notation with negative exponents.

Probability is expressed as a number between 0 and 1. The notation 3.0E–06 can be used as 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., fatal cancer) will occur over the period covered by the analysis.

The health risk impacts associated with the routine operation of HW treatment facilities are presented in several tables in this section. Summary tables show programwide results by alternative. The site data tables in Volume II present the health impacts for all sites.

10.4.1.1 Estimated Number of Fatalities

On a programwide basis, waste management worker physical hazard fatalities did not equal or exceed one under any of the alternatives evaluated. On a site-level basis, worker fatalities did not equal or exceed one at any HW treatment site under any alternative.

10.4.1.2 Estimated Number of Cancer Incidences

Table 10.4–3 presents an overview, by alternative, of the total estimated programwide cancer incidences associated with treatment of HW. These impacts result from chemical exposures of the offsite population, noninvolved workers, and waste management workers.

The number of cancer incidences on a programwide basis are estimated to be less than one for all receptor groups except waste management workers. Programwide waste management worker cancer incidences of one and two were estimated under the Regionalized 1 and 2 alternatives, respectively. On a site-level basis, one waste management worker cancer was estimated at ORR under Regionalized Alternative 2 as a result of exposure to chromium VI. The chromium cancer risk is probably an overestimate, since all of the chromium available for exposure was conservatively assumed to be in the form of chromium VI. Cancer incidences of less than one were estimated for the offsite and noninvolved worker populations at all sites under all alternatives.

10.4.1.3 Probability of MEI Cancer Incidence

Table 10.4–4 summarizes, by alternative, the highest estimated *probability* at any site of cancer incidences resulting from chemical exposure. This table presents these estimated risks for the MEIs within the offsite population and noninvolved worker population.

Table 10.4–3. HW Treatment: Estimated Number of Cancer Incidences Programwide

Alternative	Sites[a]	Offsite Population Chemical Cancer Incidence	Noninvolved Worker Chemical Cancer Incidence	WM Worker Chemical Cancer Incidence
No Action	2	*	*	*
Decentralized	3	*	*	*
Regionalized 1	5	*	*	1
Regionalized 2	2	*	*	2

Note: * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

Table 10.4–4. HW Treatment: Greatest Probability of Cancer Incidence at Any HW Site

Alternative	Sites[a]	Offsite MEI Cancer[b] Incidence Probability	Noninvolved Worker MEI Cancer Incidence Probability
No Action	2	4E–07	2E–06
Decentralized	3	4E–07	2E–06
Regionalized 1	5	2E–06	1E–05
Regionalized 2	2	5E–06	3E–05

Note: Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] Number of DOE sites treating.
[b] The impacts presented in this table refer only to offsite populations surrounding DOE sites. Impacts to offsite populations from treatment at commercial facilities are not included.

The probability of a cancer incidence to the MEI was calculated for each site and the highest values under each alternative are presented in Table 10.4–4. The MEI risk is not a combined total of risks across all of the sites under an alternative.

The probabilities for the Regionalized Alternatives are relatively higher by about one order of magnitude (10 times) than the probabilities estimated for the No Action and Decentralized Alternatives. Four sites (the Hanford Site, INEL, LANL, ORR) are estimated to have the highest offsite or noninvolved worker MEI cancer incidence probabilities (greater than one-in-one million) from implementation of HW alternatives. Exposure to chromium VI drives the cancer risk at these sites.

10.4.1.4 MEI Noncancer Risks

The "Hazard Index" is an EPA standard indicator of potential noncancer toxicity caused by exposure to hazardous chemicals. It is derived by comparing the estimated exposure concentrations of noncarcinogenic chemicals to concentrations presumed to be protective of human health over an entire lifetime, assuming continuous low-level exposure. If the Hazard Index exceeds one, the estimated exposure concentrations exceed the concentrations presumed to be without adverse health effects. In the WM PEIS, the Hazard Index was estimated for the MEI of the offsite and noninvolved worker populations.

For waste management workers, an "Exposure Index" rather than a Hazard Index was estimated. The Exposure Index is derived by comparing the estimated exposure concentrations to appropriate occupational exposure limits. The Exposure Index was considered to be a better measure for waste management workers because the Hazard Index uses standards designed to protect the health of the general population, including sensitive subgroups, such as children. Workers are generally assumed to be healthier than the general population, and worker populations do not contain sensitive subgroups. Therefore, the concentrations of noncarcinogenic chemicals presumed to be protective of human health are different for these two groups of receptors. If the Exposure Index exceeds one, the estimated concentrations exceed the concentrations presumed to be without adverse health effects.

Table 10.4–5 summarizes, by alternative, the programwide noncancer health risks resulting from chemical exposures associated with each HW alternative. This table presents the greatest noncancer health risks (presented as "Hazard Index") to the MEIs within the offsite and noninvolved worker populations, and to an individual waste management worker (presented as "Exposure Index") across the treatment sites.

None of the alternatives are estimated to produce noncancer risks at levels of concern to the MEIs of the offsite and noninvolved worker populations. However, the Exposure Index values for the waste management workers exceed one for each of the alternatives, indicating the potential for adverse noncancer health effects as a result of worker exposures. Five sites (the Hanford Site, INEL, LANL, ORR, and SRS) are estimated to have noncancer risks to the most exposed waste management worker, with Exposure Indices equal to or greater than one. Noncancer risks are of concern at ORR under each of the alternatives. At the other sites, noncancer risks are estimated mainly under the regionalized alternatives, although INEL

Table 10.4–5. HW Treatment: Greatest Noncancer Health Risks at Any HW Site

Alternative	Sites[a]	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Incidence	WM Worker Exposure Index
No Action	2	*	*	4
Decentralized	3	*	*	4
Regionalized 1	5	*	*	6
Regionalized 2	2	*	*	6

Notes: Hazard Index = sum of Hazard Quotient values for all noncarcinogenic chemicals; Hazard Quotient = the chemical-specific ratio of media exposure concentration to concentrations believed to have no appreciable adverse effects; Exposure Index = ratio of exposure concentration to chemical-specific occupational threshold limit; * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

and LANL have such risks under the No Action and Decentralized Alternatives, respectively. Hydrogen chloride is the noncancer risk driver at these sites.

10.4.2 TRANSPORTATION-RELATED IMPACTS

Although HW can be transported both by truck and rail, truck transportation is the predominant shipping method. Therefore, transportation impacts were estimated based solely on truck transportation. Potential health impacts from the transportation of HW were considered to be the result of exposure to vehicle exhaust during transportation operations, and exposure to HW chemicals due to transportation accidents in which HW shipment containers are breached. Physical injuries and fatalities sustained during vehicle accidents were also included in the transportation-related health impacts. The populations potentially affected in the transportation of HW are the public along transportation routes and the truck crews transporting the HW.

Some HW would be shipped to commercial vendors for treatment under all HW management alternatives. Therefore, shipments of HW were considered to occur uniformly over the 20-year construction and operation period. Appendix E describes the methods used to estimate the health risks from transporting HW.

Table 10.4–6 presents the health risk impacts from exposure to HW chemicals released as a result of transportation accidents. The estimated health risk impacts are based on the types of HW chemicals present and differing levels of concentrations released.

The exposed population includes the truck transportation workers and assumes the accident and release of HW chemicals take place in a populated urban area. The probability of an accident occurring with the most toxic chemicals present in large quantities, high population density, and meteorological conditions favoring extremely limited dispersal of the chemicals would be very low. For example, 285 of the estimated 1,700 shipments over a 20-year period under the No Action Alternative would involve HW chemicals that are considered as having a potential for causing "any adverse effect." Of those 285 shipments, only 36 of the shipments contain the combinations of HW chemicals that would contribute more than 50% of the adverse health risk. This amounts to 2/100ths of 1% of all HW shipments over 20 years. This relationship would also be true for the other HW alternatives.

Table 10.4–6. Health Risks From Chemical Exposure Following HW Transportation Accidents

HW Alternatives	Sites[a]	Shipment Miles (Millions)	Number of Shipments	Number of Potential Life Threatening Effects	Number of Potential Cancers	Number of Potential Adverse Noncancer Effects
No Action	2	20	34,000	*	2	78
Decentralized	3	19	41,500	*	1	49
Regionalized 1	5	35	50,000	*	3	86
Regionalized 2	2	19	34,000	*	2	60

Note: * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

Table 10.4–7 summarizes the total number of estimated fatalities associated with truck transportation of HW and provides the total number of shipments, the total shipment miles, and the source of the fatalities for each alternative. Regionalized Alternative 1 is the only alternative that is estimated to result in a fatality as a result of traffic accidents. None of the other alternatives are estimated to produce fatalities as a result of implementation of HW alternatives.

Table 10.4–7. Estimated Fatalities for HW Truck Transportation From Vehicular Accidents

Alternative	Sites[a]	Number of Shipments	Shipment Miles (Millions)	Source of Fatalities	
				Fuel Emissions	Injury from Traffic Accidents
No Action	2	34,000	20	*	*
Decentralized	3	41,500	19	*	*
Regionalized 1	5	50,000	35	*	1
Regionalized 2	2	34,000	19	*	*

Note: * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

10.4.3 FACILITY ACCIDENT IMPACTS

10.4.3.1 Storage Facility Accidents

Although DOE does not intend to make any HW storage decisions as a result of this PEIS, limited storage (or staging) is necessary to facilitate treatment. Therefore, health risks were evaluated for a number of potential HW storage facility accidents. The accidents analyzed included: (1) a fire that engulfs a significant number of HW containers; (2) an earthquake that ruptures a significant number of containers; and (3) the crash of a large or small aircraft into the facility resulting in fire and explosion. Additional information about the methods and assumptions used in the facility accident analysis, as well as details about the individual accident scenarios, can be found in Appendices D and F. Note that facility accidents were analyzed only under the regionalized alternatives because these alternatives had the largest estimated inventories of waste, and therefore, the largest potential consequences following an accident. Analyzing only these alternatives should provide an estimate of the potential maximum risks under all alternatives.

Table 10.4–8 summarizes the estimated cancer incidences resulting from chemical exposures associated with potential storage facility accidents. This table contains cancer incidence and frequency of occurrence estimates for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2. None of the receptor groups are estimated to have cancer incidences equal to or greater than one as a result of accidents related to storage of HW at any of the sites evaluated.

Table 10.4–9 summarizes the estimated noncancer risks to the MEI resulting from chemical exposures associated with potential HW storage facility accidents. This table contains noncancer risk and frequency of occurrence estimates (presented as a "Hazard Index" or an "IDLH [Immediately Dangerous to Life and Health] Index") for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2.

Regionalized Alternative 2 appeared to have the higher risks of the two alternatives evaluated, although noncancer risks are estimated to occur in each of the receptor groups at each of the sites evaluated under both alternatives if the accidents were to occur.

Table 10.4-8. Cancer Incidences From Potential Maximum Reasonably Foreseeable HW Storage Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite Population Number of Cancer Incidences	Noninvolved Workers Number of Cancer Incidences	WM Workers Number of Cancer Incidences
Regionalized Alternative 1					
Hanford	Storage facility fire	1.0E-04 to 1.0E-02	*	*	*
INEL	Large aircraft crash	<1.0E-06	*	*	*
LANL	Small aircraft crash	<1.0E-06	*	*	*
ORR	Small aircraft crash	<1.0E-06	*	*	*
SRS	Large aircraft crash	<1.0E-06	*	*	*
Regionalized Alternative 2					
INEL	Large aircraft crash	<1.0E-06	*	*	*
ORR	Small aircraft crash	<1.0E-06	*	*	*

Note: * = greater than 0 but less than 0.5.

Table 10.4-9. Noncancer Risks From Potential Maximum Reasonably Foreseeable HW Storage Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker IDLH Index
Regionalized Alternative 1					
Hanford	Large aircraft crash	<1.0E-06	1	6	1,400
INEL	Large aircraft crash	<1.0E-06	2	14	530
LANL	Small aircraft crash	<1.0E-06	32	450	2,700
ORR	Small aircraft crash	<1.0E-06	77	850	680
SRS	Large aircraft crash	<1.0E-06	2	110	1,300
Regionalized Alternative 2					
INEL	Large aircraft crash	<1.0E-06	37	330	6,200
ORR	Small aircraft crash	<1.0E-06	240	2,600	2,300

Note: IDLH = immediately dangerous to life and health.

10.4.3.2 Treatment Facility Accidents

The thermal treatment facility (incinerator) accidents evaluated included: (1) explosion and resulting feedstock fire; (2) earthquake followed by a facility fire; and (3) the crash of a large or small aircraft into the facility resulting in a facility fire.

Table 10.4–10 summarizes the estimated cancer incidences resulting from chemical exposures associated with potential treatment facility accidents. This table contains cancer incidence and frequency of occurrence estimates for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2. None of the receptor groups are estimated to have cancer incidences equal to or greater than one as a result of accidents related to treatment of HW at any of the sites evaluated.

Table 10.4–11 summarizes the estimated noncancer risks to the MEI resulting from chemical exposures associated with potential treatment facility accidents. This table contains noncancer risk estimates for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2. Noncancer risks are estimated to occur in each of the receptor groups at most of the sites evaluated under both alternatives if the accidents were to occur.

Table 10.4–10. Cancer Incidences From Potential Maximum Reasonably Foreseeable HW Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite Population Number of Cancer Incidences	Noninvolved Workers Number of Cancer Incidences	WM Workers Number of Cancer Incidences
Regionalized Alternative 1					
Hanford	Large aircraft crash	<1.0E–06	*	*	*
INEL	Large aircraft crash	<1.0E–06	*	*	*
LANL	Earthquake and fire	1.0E–06 to 1.0E–04	*	*	*
ORR	Small aircraft crash	<1.0E–06	*	*	*
SRS	Large aircraft crash	<1.0E–06	*	*	*
Regionalized Alternative 2					
INEL	Earthquake and thermal treatment unit fire	<1.0E–06	*	*	*
ORR	Small aircraft crash	<1.0E–06	*	*	*

Note: * = greater than 0 but less than 0.5.

Table 10.4-11. Noncancer Risks From Potential Maximum Reasonably Foreseeable HW Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker IDLH Index
Regionalized Alternative 1					
Hanford	Large aircraft crash	<1.0E-06	0.2	1	360
INEL	Large aircraft crash	<1.0E-06	0.08	0.5	230
LANL	Earthquake and fire	1.0E-06 to 1.0E-04	1	8	200
ORR	Small aircraft crash	<1.0E-06	7	7	320
SRS	Large aircraft crash	<1.0E-06	0.08	4	120
Regionalized Alternative 2					
INEL	Earthquake and thermal treatment unit fire	<1.0E-06	2	12	990
ORR	Small aircraft crash	<1.0E-06	11	11	560

Note: IDLH= immediately dangerous to life and health.

10.5 Air Quality Impacts

The management of HW would not appreciably affect the air quality at most sites. No site would equal or exceed criteria air pollutant standards. However, regionalization of treatment facilities at LANL and ORR could cause adverse air quality impacts requiring additional emission control measures primarily due to emissions of hazardous pollutants from thermal treatment.

As illustrated in Table 10.5-1, DOE evaluated air quality impacts at each proposed HW treatment site based on estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (HAPs), and toxic air pollutants (TAPs). Emissions of radionuclides are not applicable because HW does not contain radionuclides. DOE estimated pollutant emissions for HW facility construction activities and for operation and maintenance activities.

The Clean Air Act (42 USC 7401 *et seq.)* regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new emissions from both "stationary" (e.g., treatment facilities) and "mobile" (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for

Table 10.5–1. Air Quality Impacts Evaluated for HW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Text discussion only
	Operations	Estimated for thermal treatment units, for fuel use by all other HW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Table 10.5–2
Hazardous and toxic air pollutant emissions	Operations	For all HW treatment facilities	Percent of standard	Table 10.5–3

each criteria air pollutant for nonattainment areas. An entity which seeks to engage in an activity that will result in emissions equal to or exceeding those limits in a nonattainment area must first obtain a permit.

In "attainment areas" (where air pollution standards are met), only new emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit is required for a new stationary source that equals or exceeds the allowable increase. However, a permit is not required for criteria air pollutant emissions from mobile sources.

10.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site (mobile sources).

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities under the HW alternatives would result in

Major Types of Air Pollutants

Criteria Air Pollutants: *carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*

Hazardous Air Pollutants: *189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

Toxic Air Pollutants: *Other toxic compounds regulated by EPA and state or local governments* emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. DOE chose the 10% threshold to highlight sites where criteria air pollutant emissions could result in adverse air quality impacts.

DOE estimates that no site would have emissions from construction activities that would equal or exceed 10% of allowable levels. Therefore, no site would need to obtain a Clean Air Act permit.

10.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants are also emitted during operation and maintenance of HW facilities (stationary sources) and by vehicles that are driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

Of the nine major HW sites, only ORR and INEL would equal or exceed 10% of applicable air pollutant emission standards (Table 10.5–2). Both sites are located in attainment areas. Although ORR would equal or exceed 10% of the PM_{10} standard under both the Regionalized Alternatives 1 and 2 and INEL would exceed 10% of the PM_{10} standard under Regionalized 2, no site would equal or exceed any of the criteria air pollutant emission standards or need to obtain a Clean Air Act permit.

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 km (62 miles) of a PSD Class I area. Five sites proposed for HW activities under the alternatives are located within 100 km of a PSD Class I area: INEL, LANL, LLNL, ORR, and SNL-NM. None of these would have sufficient quantities of emissions to affect a PSD Class I area.

Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). No site was estimated to equal or exceed 10% of the standards.

Table 10.5-2. Percent of Sites' Allowable Air Emissions Discharged During Operations—HW Sites Equaling or Exceeding 10% of Standard

Alternative	Number of Treatment Sites	Criteria Pollutants (PM_{10}) Operation and Maintenance	
		INEL[a]	ORR[a]
No Action	2		
Decentralized	3		
Regionalized 1	5		10
Regionalized 2	2	17	13

Note: PM_{10} = particulate matter less than or equal to 10 micrometers in diameter. Values less than 10% are shown as blanks.
[a] Attainment area for this pollutant; PSD regulations are applied; total % represents stationary-source emissions only.

10.5.3 Hazardous and Toxic Air Pollutant Emissions

Thermal treatment of HW will result in emission of small quantities of hazardous and toxic air pollutants. Hazardous air pollutants (HAPs), other than radionuclides, and toxic air pollutants (TAPs) were evaluated by comparing estimated ambient concentrations to EPA guidelines and State Ambient Allowable Limits (AALs). Radionuclides emissions are not applicable because HW does not contain radionuclides.

As shown in Table 10.5-3, only vinyl chloride concentrations at LANL and ORR were estimated to equal or exceed 10% of the applicable guidelines or standards. These concentrations exceeded the standard for

Table 10.5-3. Percent of the Standard for Hazardous and Toxic Air Pollutants—HW Sites Equaling or Exceeding 10% of Standard

Alternative	Number of Treatment Sites	HAPs/TAPs (Vinyl Chloride[a])	
		LANL	ORR
No Action	2		14
Decentralized	3		35
Regionalized 1	5	153	120
Regionalized 2	2		322

Notes: HAPs = hazardous air pollutants; TAPs = toxic air pollutants. Values less than 10% are shown as blanks.
[a] Vinyl chloride exceeds 10% of the EPA Integrated Risk Information System annual toxic value of 0.012 $\mu g/m^3$.

both LANL and ORR in Regionalized Alternative 1, and ORR in Regionalized Alternative 2. These results are primarily due to the thermal treatment of HW, and may require additional control measures to reduce emissions to acceptable levels.

10.6 Water Resources Impacts

Major impacts to water resources at the HW sites are unlikely for treatment under any alternatives.

As illustrated in Table 10.6–1, DOE analyzed the impacts on water resources of HW treatment activities. Disposal of HW is not within the scope of the WM PEIS. DOE evaluated the effects on water availability from building and operating treatment facilities.

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

10.6.1 WATER AVAILABILITY

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of HW facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite stream at a given site.

Table 10.6-1. Water Resource Impacts Evaluated for HW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used • by personnel • by treatment processes	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only

As shown in the Volume II tables, projected water usage would be less than 1% of current use at all sites. The 1% threshold is based on the assumption that changes less than or equal to 1% are not likely to have significant impacts. Therefore, no site is likely to experience adverse impacts because of the relatively small amount of additional water needed.

For DOE sites that withdraw water directly from a surface water source (the Hanford Site and ORR), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (ANL-E, ORR, and SRS), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

10.6.2 Water Quality

Impacts to groundwater quality were not evaluated for HW. Because HW disposal is conducted by commercial disposal facilities, the impacts to water quality would be analyzed by the commercial operator.

10.7 Ecological Resources Impacts

Loss of limited acreages of habitat at some HW sites during construction of HW facilities would not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. DOE should be able to locate new HW facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction site acreages are small compared to the total acreage at each site suitable for waste operations. A screening-level risk assessment of facility airborne emissions indicated that terrestrial wildlife species are not likely to be affected. Transportation accidents leading to spills of HW into aquatic environments could have serious short- and long-term consequences, but the long-term consequences could be mitigated in many instances through emergency response cleanup activities.

As illustrated by Table 10.7–1, DOE analyzed the effects of construction site clearing to build HW treatment facilities, and the operation of treatment facilities on ecological resources at the five large HW treatment sites. DOE qualitatively considered the effects of accidental spills of HW during transport.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

10.7.1 General Impacts of Site Clearing

None of the alternatives would require extensive site clearing for construction of HW facilities. Acreage requirements at any site under any alternative are less than or equal to the 3 acres required at INEL under the Regionalized Alternative 2. These acreage requirements are minimal compared with the regional extent of habitats for nonsensitive species at the sites. Although site clearing would destroy individual plants and would kill or displace individual animals (particularly small mammals and song birds with limited home ranges), no significant effects to populations of these species are expected from implementation of any HW alternative.

Table 10.7–1. Ecological Resource Impacts Evaluated for HW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at HW construction sites to general habitat range.	Text discussion
Terrestrial species exposures	Terrestrial animal species	Comparison of estimated hazardous chemical exposures for representative species with the toxicity standard.	Text discussion
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats based on comparing construction acreage to available acreage of nonsensitive habitats.	Text discussion
Sensitive species concerns	Federally and State-listed endangered and threatened species	Numbers of Federally- and State-listed species displayed by site/alternative.	Table 10.7–2
Effects of transportation accidents	Aquatic species in streams crossing transportation corridors	Comparison of accidental spills into aquatic habitats based on number of HW shipments.	Text discussion

10.7.2 Site Clearing Effects on Sensitive Habitats

For those sites that contain sensitive habitats, the degree to which they may be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby HW construction activities depends on DOE's ability to avoid siting near these habitats. A measure of this ability is the percentage of available land required for facility construction at a site under any HW alternative. Available acreage was estimated from site development plans either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage ranged from 0.0007% at SRS under the Decentralized Alternative and Regionalized Alternative 1 to 0.04% at ORR under the Regionalized Alternative 2. Considering these small fractions of available land required for the HW facilities, DOE would have a great degree of flexibility in its siting and can employ a range of mitigative measures, so that site clearing to implement any of the HW alternatives should not affect adjacent sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff of water and soil to surface waters from construction sites. However, proper construction practices would minimize these effects. Direct discharges to surface waters from the routine operation of treatment facilities would comply with applicable regulations and would be limited by the use of accepted engineering techniques. Therefore, the impacts to aquatic organisms are expected to be minimal.

10.7.3 Effects of HW Treatment Facility Emissions

DOE used atmospheric emissions and deposition modeling to estimate the toxicity to terrestrial animals from airborne emissions of hazardous chemicals from treatment facilities. This analysis used the same atmospheric emissions estimates as the human health risk assessment and provided estimates of chemicals deposited on surface soils.

For this analysis, DOE examined those sites with the highest anticipated emissions. Emissions of the following hazardous chemicals were evaluated: arsenic; cadmium; chromium (VI); copper; lead; mercury; nickel, zinc, dioxins, and furans. Hazard Indices were computed for each selected site-alternative combination as composite ratios between the estimated species exposures to the contaminants and known toxic levels for the species. Hazard Indices greater than one would indicate a potential for the combined exposures to adversely affect the health of the species. The maximum estimated Hazard Index values were less than 0.01 for all sites under all alternatives. Therefore, no impacts to terrestrial receptor populations from emissions of hazardous chemicals from HW treatment facilities are expected. Additional information on the methods used to assess potential toxicity to terrestrial animals and on the results of the analysis is presented in Section C.4.4 of Volume III and the Appendix C technical report.

10.7.4 Consideration of Sensitive Species

For comparison of the HW management program's potential to affect sensitive species, Table 10.7–2 lists the numbers of Federally- and State-listed sensitive species occurring or potentially occurring at each HW site that is proposed to treat HW under each alternative. Site-specific analysis would be required for an assessment of sensitive species impacts. That analysis would take into account specific locations for the HW facilities in relation to the location of sensitive habitats and sensitive species at each site, including species listed by the U.S. Fish and Wildlife Service as either endangered or threatened.

Table 10.7-2. Numbers of Federal/State-Listed Endangered and Threatened Species Occurring or Potentially Occurring at the Five Proposed HW Treatment Sites

Alternative	Number of Treatment Sites	Hanford	INEL	LANL	ORR	SRS
No Action	2	--	2/2	--	1/11	--
Decentralized	3	--	2/2	--	1/11	8/8
Regionalized 1	5	3/11	2/2	2/4	1/11	8/8
Regionalized 2	2	--	2/2	--	1/11	--

Note: -- = no major HW actions proposed at the site under the alternative.

10.7.5 EFFECTS OF HW TRANSPORTATION ACCIDENTS

Transportation accidents involving spills of HW into aquatic environments would be rare. The number of expected accidents is related to the total number of miles traveled during HW shipment (also shipment routes near aquatic habitats). Thus, as fewer shipments of HW occur, as in Regionalized Alternative 2, the number of accidents would be expected to decrease. The potential for impacts to aquatic habitats would also decrease with a decrease in miles traveled. The toxic effects on aquatic resources from HW transportation accidents could be severe immediately following a spill, but are unlikely to have long-term effects due to emergency spill response efforts.

10.8 Economic Impacts

The HW alternatives would only minimally benefit the regional and national economies. The jobs involved in managing HW under the alternatives did not equal 1% of regional employment at any site. The greatest economic effects nationally were estimated to occur under Regionalized Alternative 1, and would result in an increase of 460 jobs.

DOE estimated the effects of expenditures for HW management on the local and national economies (See Table 10.8-1). Local economic effects were based on direct expenditures at each of the five large HW generator sites that treat HW for construction, operation and maintenance, and decontamination of treatment facilities. The socioeconomic region-of-influence (ROI) consists essentially of the counties of residence of

Table 10.8–1. Economic Impacts Evaluated for HW Alternatives

Economic Impact Analyzed	Affected Aspect of the Economy	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures for HW management multiplied by regional employment multiplier at each of the five HW treatment sites	Text discussion
Increased regional incomes	Regional personal income for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional income multiplier at each site	Text discussion
National economic effects	National employment and personal income	Proposed site expenditures at all HW sites and transportation expenditures multiplied by national employment and income multipliers	Text discussion

site employees. The local economy at each site of the five sites was represented by employment, personal income, and industry data. Local increases in jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at a national level only.

Local economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined and weighted to estimate annual project effects at each site. For all alternatives, construction was assumed to take 4 years of the 10-year construction period; the operations phase was assumed to take 12 years (a 10-year operations and maintenance period and a 2-year decontamination period undertaken after the conclusion of operations). Five years was added to the decontamination and decommissioning phase to account for the continued effects on employment and income after this latter project phase ends. The sum of construction phase and operations phase effects was then divided by the total 21 years to determine the combined weighted average annual effects. Annual job and personal income increases are shown for each of the five large HW treatment sites in the Volume II site data tables.

Across the HW alternatives, the regions at all five sites would experience less than a 1% change in the number of jobs as a result of expenditures. No region would experience a 1% or greater increase in personal income under any of the alternatives. A comparison of alternatives reveals that the number of new direct, indirect, and induced jobs from the combined and weighted construction and operations and maintenance activities across site ROIs ranges from 21 (under the No Action Alternative) to about 250 (under Regionalized Alternative 2).

In addition to analyzing these impacts on the regional economy, a comparison of these impacts on the national economy was made. The HW alternatives would only minimally benefit the national economy. The total number of jobs generated in the national economy from combined weighted construction and operations phase activities range from about 150 (under the No Action Alternative) to 460 jobs (under Regionalized Alternative 1) which represents 0.0003% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. It is likely that any changes would represent a shift in the source of income from previous employment to employment in HW projects, rather than a net change in national personal income.

10.9 Population Impacts

Population increases resulting from proposed HW alternatives would be minor for all sites. Community characteristics and services would not be affected.

Population changes as a result of the in-migration of new HW workers to the ROI at each HW site were used as a basis to evaluate the likelihood of changes to the local environment. These include community size, diversity, and the provision of necessary services.

Impacts resulting from population changes were not estimated to be major for any of the proposed HW alternatives. The labor requirements and associated population in-migration were not estimated to be sufficient to change the overall population within the ROI at any site by more than 0.1%.

10.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of HW indicated that minority and low-income populations at the HW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HW alternatives.

Analysis of environmental justice impacts from management of HW was based on a review of the impacts reported in this chapter regarding the HW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the 5 large HW generator sites that serve as onsite HW treatment sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done along with maps illustrating the distribution of minority and low-income populations within 50 miles of each of these 5 large HW sites.

10.10.1 Results

The potential for adverse human health effects from exposures to chemical emissions from HW treatment facility operations and from reasonably foreseeable accidents is low for all HW management alternatives for all HW sites. Likewise, the number of cancer incidences due to chemical exposures and the number of fatalities from fuel emissions from truck or rail transportation of HW is small.

Incident-free HW treatment facility operations were analyzed in terms of risk to workers and the public. Incident-free operations present no significant risk and do not constitute a reasonably foreseeable adverse impact to the surrounding population. Table 10.4–3 in the health risk section of this chapter indicates that under all the alternatives, the estimated number of offsite population cancer incidence across all HW sites from the normal operation of DOE HW treatment facilities would be less than 0.5 during the conduct of the entire HW program.

10.10.1.1 Transportation

Incident-free HW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income populations. For incident-free transportation, the total number of life-threatening effects is less than 0.5 for any HW alternative. Fatalities from fuel emissions are expected to be less than 0.5 across the HW sites under all alternatives, and the expected number of transportation accident fatalities from trauma is no higher than one under any HW alternative.

10.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 10.10.1 did not indicate any adverse impacts to water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Air quality impacts are possible at three sites but because the air quality impacts can be mitigated by emission control measures or by using a nonthermal treatment technology. DOE does not anticipate any disproportionately high and adverse air quality impacts to any segment of the populations, including minority or low income populations, at the HW sites.

10.11 Land Use Impacts

Land required to construct HW facilities does not exceed 1% of suitable land for any site under any HW Alternative. Therefore, no impacts to current onsite land uses and no conflicts with offsite uses are expected. Site development plans indicated no conflict between proposed treatment facilities and other plans for the sites.

DOE examined the impacts of the HW alternatives on land use by comparing the acreage required for new treatment facilities to the acreage either designated for waste operations or suitable for development (See Table 10.11–1). Suitable land is the total site acreage, minus the acreage required for known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts between the proposed facilities required under each alternative and plans for future site uses.

Table 10.11-1. Land Use Impacts Evaluated for HW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each HW site	Land use shown in site development plans	Comparison of required acreage with amount designated (or estimated) for HW in site development plan—all instances where requirements are 1% or higher are noted	Text discussion only
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed HW uses and nearby land uses	Text discussion only

None of the development plans at affected sites indicated any conflicts between planned future uses and the proposed HW alternatives. Because the analysis showed that HW facilities would require less than 1% of the designated or suitable land at any site under any alternative, DOE should have considerable flexibility in locating them and no significant land use impacts onsite are expected. For the same reason, no conflicts with adjacent land uses are expected. In addition, none of the site development plans indicated any instances where future uses would conflict with the proposed HW management actions.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations on a site.

10.12 Infrastructure Impacts

Proposed HW activities show minimal potential to affect onsite or offsite infrastructure. In no case does an estimated new onsite requirement for water, wastewater treatment, or electric power approach 5% of current system capacity. Similarly, site employment increases from construction of HW facilities do not approach 5% of current site employment. Therefore, traffic increases would be minimal and would not substantially affect onsite transportation infrastructure.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and electric power (See Table 10.12–1). Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater from construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to the onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on community infrastructure.

Proposed HW activities show no potential for substantial effects on onsite or offsite demand for water, wastewater treatment, and power infrastructure. Estimated new requirements for wastewater treatment or power for proposed HW facilities do not exceed 5% of current system capacity at any site. Employment increases never approach 5% of current site employment needed to build and operate HW facilities. Therefore, it is expected that traffic increases will be minimal, and will not substantially affect onsite transportation infrastructure. Operations phase site employment will be lower than construction phase employment so no transportation infrastructure effects are expected.

Table 10.12–1. Infrastructure Impacts Analyzed for HW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support HW facilities	Capacity of onsite water, power, and wastewater systems	Add increased HW facility use to current use—compare to current capacities	Text discussion only
	Onsite transportation infrastructure	Compare new site employment with current site employment as an indicator of increased stress	Text discussion only
Capacity of community infrastructure to support increased worker populations and their families	Regional water, power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion only

10.13 Cultural Resources Impacts

Construction and operation of HW facilities could adversely affect cultural resources. DOE will conduct further impact assessment cultural resources surveys when specific HW facility locations are proposed to ensure that any potential impacts are mitigated.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where HW treatment facilities are proposed to be built.

Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys at the five major proposed HW sites and lists reported cultural resources at those sites. However, the impacts of the construction of HW facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Land requirements for the construction of HW waste management facilities are sufficiently small under all alternatives that DOE would probably have enough flexibility in siting HW facilities to avoid impacts on cultural resources. If not, measures would be taken to mitigate negative effects on these resources.

10.14 Costs

Costs for commercial treatment are less than for government treatment because of the relatively small volume of HW generation reported. Transportation costs are 15% to 34% of total costs.

As indicated in Table 10.14–1, DOE estimated costs for building and operating treatment facilities, and for transportation (INEL, 1995a,b). DOE evaluated costs associated with HW management from both a life-cycle and process perspective, using 1994 dollars.

10.14.1 Life-Cycle Costs

DOE evaluated government facility costs for four phases representing the life-cycle of the facilities and their operations: pre-operations, construction, operations and maintenance, and decontamination and decommissioning. These phases have been described in previous Chapters 6–8, and are the same for the HW cost estimate. Commercial costs are contractor payments, which fall wholly within the operations phase of the life-cycle. The transportation cost estimates include costs of truck transportation from generating sites to treating sites or to commercial vendors. Life-cycle costs do not include speculative factors, such as impacts to long-term land values.

10.14.2 Process Costs

DOE also analyzed costs based on treatment and storage activities. Government treatment costs include costs to build and operate treatment facilities (such as thermal treatment units) and common support facilities (such as maintenance, and certification/shipping facilities). Facilities are assumed to be Government-owned,

Table 10.14–1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts Are Assessed	Location of Impacts Assessment
Process costs	Government treatment[a]	Life-cycle costs for facilities	Table 10.14–2
	Commercial treatment[a]	Life-cycle costs for facilities	Table 10.14–2
Transportation costs[b]	Truck[a]	Inter-site common carrier costs for transportation from generating sites to treating sites, and to disposal sites	Table 10.14–2

[a] HW would be shipped to commercial vendors for treatment and disposal under all HW management alternatives. Therefore, shipments of HW were considered to occur uniformly over the 20-year construction and operation period.
[b] Rail costs were not estimated because the small volumes did not warrant rail shipment.

contractor-operated on DOE sites. Because of the small volume of most waste streams, it was not economically feasible to construct and operate government facilities. For organic liquids, waste volumes were high enough to warrant evaluation of government owned facilities. The Government facilities included several technologies—thermal treatment, aqueous treatment of scrubber blowdown, and grout solidification of fines and residues. The details of cost estimating are covered in Section 5.3.3, Volume I.

Commercial treatment includes those costs incurred for vendor treatment. DOE applied unit prices derived from vendor quotes for the following: thermal treatment and the supporting treatments of aqueous waste, organic removal, metal recycling, reactive metal deactivation, mercury recovery, and grout solidification.

As shown in Table 10.14–2 (INEL, 1996), the No Action Alternative is the least costly of the alternatives at an estimated $144 million, with only 3% of the nonwastewater HW being treated by government facilities. The Decentralized Alternative, which treats 9% of the nonwastewater HW in government facilities at three sites, is the second least expensive alternative at $183 million. Regionalized Alternative 1, which treats 50% of the nonwastewater HW in government facilities at five sites, is the most expensive at $376 million, closely followed by Regionalized Alternative 2, which treats 90% of the nonwastewater HW

Table 10.14–2. Life-Cycle Costs
(Millions of 1994 Dollars)

Alternatives	Number of Treatment Sites	Total Costs (including truck transportation)	Life-Cycle Costs				Process Costs[a]		Transport Costs
			Pre-ops	Const	O&M	D&D	Comml T	Govt T&D	Truck
No Action	2	144	0	0	95	0	73	22	49
Decentralized	3	183	3	20	104	7	71	63	49
Regionalized 1	5	376	18	83	183	5	50	239	87
Regionalized 2	2	318	18	75	172	6	28	243	47

Notes: Pre-ops = preoperations; Const = construction; O&M = operations and maintenance; D&D = decontamination and decommissioning; Comml T = commercial treatment; Govt T&D = government treatment; Total costs = sum of life cycle costs plus truck transport = sum of process costs plus truck transport.
[a] Total Facility Costs are presented twice in this table: as life-cycle costs and as process costs. The sum of life-cycle costs is equal to the sum of process costs. Total Costs, also in the table, add truck costs to the facility costs. Therefore, Total Costs equals the sum of life-cycle costs and truck costs and also equals the sum of process costs and truck costs.

at two sites and costs $318 million. Conversely, commercial treatment costs are highest for the No Action Alternative and lowest for the Regionalized Alternative 2. Based on the reported waste volumes of 3,400 metric tons per year, the continued use of commercial vendors is the most cost-effective method of treatment. Transportation costs are relatively constant at $47–49 million for all alternatives except the Regionalized Alternative 1. Regionalized Alternative 1 has a much higher transportation cost ($87 million) because the shipping configuration includes a much larger number of small local shipments, thereby losing the economy of scale associated with larger capacity shipments (INEL, 1995a).

For the purpose of the WM PEIS analysis, DOE assumed existing storage capacity would be sufficient. Therefore, estimates of costs for HW do not include storage facilities.

10.15 Environmental-Restoration-Transferred Waste

DOE anticipates that volumes of HW generated during environmental restoration activities would be treated offsite at commercial facilities. Environmental-restoration HW will not be transferred to DOE HW treatment facilities.

10.16 Comparison of Alternatives Summary

Health Risk Impacts. The risk estimates indicate a fraction of a single fatality for each of the proposed HW alternatives from vehicle accidents associated with HW transportation. The Regionalized Alternatives result in greater worker exposure to HW chemicals than the No Action and Decentralized Alternatives because DOE treats more HW under the Regionalized Alternatives. This analysis did not evaluate the risk to workers at commercial facilities which are the principal HW treatment facilities under the No Action and Decentralized Alternatives. It is expected that HW worker risk would be the same regardless of whether commercial or DOE facilities are used. In view of this, there is no significant difference between the alternatives with regard to HW worker risk.

Air Quality Impacts. The management of HW would not appreciably affect the air quality at most sites. No criteria air pollutants would exceed standards at any site. However, regionalization of treatment facilities at LANL and ORR would cause adverse air quality impacts requiring additional emission control measures for vinyl chloride. The exceedances at LANL and ORR are primarily due to emissions from thermal treatment. Emissions of radionuclides are not applicable since HW does not contain radioactive constituents.

Other Environmental Impacts. Results for ecological, cultural, and other environmental impacts did not indicate significant impacts for any of the HW alternatives, and therefore no meaningful comparison or discriminators between alternatives can be determined from these impact areas.

Commercial Treatment. In addition to worker risks, the environmental impacts were not analyzed for commercial treatment facilities which treat almost all nonwastewater DOE HW under the No Action and Decentralized alternative. Analysis of these impacts would require being able to determine the fraction of DOE HW contained in all waste treated at every commercial facility, the environmental setting and meteorology of each facility, and the total number of workers at each facility. Not all of this information is publicly available, and analyzing potential impacts at each facility based on fractional contributions of DOE HW would be extremely difficult with potentially large uncertainties and inaccuracies.

The No Action and Decentralized Alternatives are unique in several specific areas:

- Health risks were not estimated for commercial facilities as discussed above, but should not be different from risks estimated for the alternatives involving DOE treatment.
- Construction jobs would increase in the short term if DOE builds its own treatment facilities, but a one-for-one switch of commercial jobs to Federal jobs would be expected as operation of DOE facilities displaces operations in commercial facilities.
- Impacts dependent on location of facilities (e.g., air quality, water resources, ecological, environmental justice) may be more likely for commercial than DOE facilities since commercial facilities would probably be located in more densely populated areas than DOE sites.

The fundamental differences among the alternatives involve transportation and the implementation costs of the HW alternatives. Table 10.16–1 presents a summary of the transportation and cost differences among the alternatives.

The Preferred Alternative. The Department's preferred alternative for HW is the No Action Alternative, which means the Department would continue to use commercial facilities to treat most of its nonwastewater HW. The transportation and environmental impacts are low for all of the alternatives for HW evaluated in the WM PEIS; however, the No Action Alternative costs less than the Decentralized or Regionalized

Alternatives for HW treatment. The impacts for the preferred alternative are those presented for the No Action Alternative throughout Chapter 10.

Table 10.16-1. Summary Comparison of the HW Alternatives

Alternative	Sites	Shipments		Costs[c]			Transportation Risks[d]
		Mileage[a]	Number[b]	Transport	Project Life-Cycle	Total	
No Action	2	20	34	49	95	144	*
Decentralized	3	19	41	49	134	183	*
Regionalized 1	5	35	50	87	289	376	1
Regionalized 2	2	19	34	47	271	318	*

Note: * = greater than 0 but less than 0.5.
[a] Mileage in millions.
[b] Number of shipments in thousands.
[c] Cost in millions of dollars.
[d] Transportation risks in fatalities.

Chapter 10
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Hazardous Waste Alternatives

Alternative	Sites[a]	ANL-E[b]	Hanford	INEL	LANL	LLNL[b]	ORR	Pantex[b]	SNL-NM[b]	SRS
No Action	2			T			T			
Decentralized	3			T			T			T
Regionalized	5		T	T	T		T			T
Regionalized	2			T			T			

Notes: T=treatment. A blank indicates that a site does not treat HW under the specified alternative. Fermi and KCP were not included in this table because they were not major sites (as described in Section 1.6 of Chapter 1) and impacts were not evaluated at those sites.

[a] Number of sites treating HW.

[b] These sites are listed because they are major sites that are large HW generators. However, because they are assumed to continue to ship nonwastewater HW offsite for treatment, no significant impacts are expected at these sites under any of the HW alternatives.

CHAPTER 11
Cumulative Impacts

Chapter 11 discusses the combined impacts that could result from locating facilities for management of different waste types at each of the 17 major waste management sites, the cumulative impacts that could result at each of the 17 major sites and their surrounding regions, and the cumulative impacts of transporting waste. The chapter presents the minimum and maximum impacts of the waste management program at each site as well as the impacts of the preferred alternatives at each site.

Cumulative impacts are those impacts that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions. Examples of past and present actions include potential impacts from contaminated sites, ongoing activities that result in waste generation and waste management activities outside the scope of the WM PEIS. Both the Council on Environmental Quality and the U.S. Department of Energy (DOE) regulations for implementing National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*) require the assessment of cumulative impacts because significant impacts can result from several smaller actions that, by themselves, may not have significant impacts. To conduct the cumulative impacts analysis, DOE first examined the **combined impacts** of waste management alternatives (including the preferred alternatives identified in Section 3.7) for the five types of wastes analyzed in the WM PEIS for each of the 17 major sites. To these combined impacts, DOE then added the impacts of other past, present, and reasonably foreseeable future actions external to the WM PEIS analysis in order to assess the **cumulative impacts**.

Combined Impacts, in this WM PEIS, are those impacts resulting from the operations of multiple waste management facilities at a particular site, as defined in the WM PEIS analysis of alternatives.

Cumulative Impacts, as defined by the Council on Environmental Quality NEPA regulations, are the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7).

11.1 Combined Waste Management Impacts

The combined impact analysis considers the following impact areas:

Human Health Risk

- Collective radiation dose and cancer risk for the public (over the 10-year period of operations)

- Annual radiation dose for the hypothetical maximally exposed offsite individual resulting from normal operations
- Collective radiation dose and cancer risk for noninvolved workers (over the 10-year period of operations)
- Annual radiation dose for the hypothetical maximally exposed offsite individual resulting from waste shipments

Environmental Quality

- Air quality exceedances (list of those emissions that could exceed air quality standards)
- Groundwater quality exceedances (list of contaminants that could exceed drinking water standards as a result of disposal of LLMW and LLW)

Resource and Infrastructure Requirements

- Land requirements (acres of land occupied by new facilities)
- Water use (gallons of water used per day during operations)
- Wastewater production (gallons of sanitary wastewater produced each day during operations)
- Power requirements (megawatts of power used during operations)

Socioeconomic Factors

- Regional employment (percent change in regional employment resulting from operations)
- Regional population (percent change in regional population resulting from operations)
- Cost (life-cycle cost in 1994 dollars)

These are the major factors that might be additive across waste types and could logically be combined.

Other impacts that were addressed in Chapters 6 through 10 were not considered part of the identification of combined impacts for several reasons. Some impacts, such as impacts to ecological resources and cultural resources, were not combined because they are dependent on the facility location within the site boundary and location-specific environmental factors. This programmatic EIS does not address these issues. Some impacts, such as impacts of waste facility accidents, were not combined because it is highly improbable that they would occur together. Risks to individual waste management workers were not considered part of the combined impact analysis because each worker was assumed to be dedicated to a single waste type (i.e., the worker at one waste type facility would not simultaneously be working at another waste type facility). In addition, DOE limits the dose to each involved worker through the use of health and safety standards and monitoring. Finally, human health risks resulting from potential groundwater contamination after the disposal of low-level waste (LLW) and low-level mixed waste (LLMW) were not considered because it was assumed that they would neither merge nor co-mingle within 300 m of a single unit. At greater distances, groundwater plumes from multiple units probably do mix, but it is likely that dilution and dispersion would lower concentrations to less than those estimated at 300 m.

Because the alternatives for the five waste types can be combined in numerous ways (for some sites, there are thousands of possible combinations of alternatives across all the waste types), the combined impacts of placing multiple facilities at each site were determined by identifying the *minimum* and *maximum* values for each of the combined impact areas (listed above) for each waste type. The values were then summed for each impact area to determine the combined minimum and maximum impacts for each site. Table 11.1–1 lists the alternatives under which a waste type facility could be located at each major site, except for onsite LLMW wastewater treatment and LLW minimum treatment facilities that would occur under all the LLMW and LLW alternatives. Table 11.1–2 lists the preferred alternatives for each site and the waste types at these sites. In the following discussions, a combined impacts table is presented for each major site; the table identifies the minimum and maximum impact values and the alternatives associated with these values. The minimum and maximum impact values are based directly on the data contained in the site data tables in Volume II of this WM PEIS for normal facility operations and on ANL (1996a-e) for site-specific transportation effects.

When reviewing the impacts and costs identified for the No Action Alternative for LLMW and TRUW, it is important to realize that the results for indefinite storage of those waste types are based on the initial 20 years of that indefinite period. This is consistent with the period of analysis for the other alternatives; however, not shown are the impacts from storage expected beyond this 20-year time frame. The longer term storage impacts and costs are likely to exceed those for the first 20 years, not only as a result of routine indefinite storage operations, but also from degradation of facilities and containers. This differs from the effects predicted for the action alternatives for management of the 20-year forecast of LLMW and TRUW, where risks to workers and the offsite population, and other impacts and costs, are reduced following disposal. The No Action Alternative does not reduce or avoid impacts and costs; rather it causes impacts and costs to be experienced every year for an indefinite period of time. A discussion of the longer term

Table 11.1-1. Major Waste Management Sites and Alternatives[a]

Sites	Waste Types	Alternatives		
		Treatment	Storage	Disposal
Argonne National Laboratory - East, IL	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Brookhaven National Laboratory, NY	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
Fernald Environmental Management Project, OH	LLMW	Decentralized and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2	None	Decentralized and Regionalized 1 and 2
Hanford Site, WA	LLMW	All	No Action	All
	LLW	Regionalized 2, 4, 5, Centralized 3-5 All	None	No Action, Decentralized, Regionalized 1-6, Centralized 1, 3, and 5
	TRUW	None	All	None
	HLW	Regionalized 1	All	None
	HW		None	None
Idaho National Engineering Laboratory, ID	LLMW	All	No Action	All
	LLW	Regionalized 2, 4, 5, Centralized 3 and 4	None	No Action, Decentralized, Regionalized 1-5
	TRUW	No Action, Decentralized, Regionalized 1-3	No Action, Decentralized, Regionalized 1-3	None
	HLW	None	All	None
	HW	No Action, Decentralized, Regionalized 1 and 2	None	None
Lawrence Livermore National Laboratory, CA	LLMW	Decentralized and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2 and No Action	None	Decentralized and Regionalized 1 and 2
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Los Alamos National Laboratory, NM	LLMW	Decentralized, Regionalized 1 and 2	No Action	Decentralized, Regionalized 1, 2, and 4
	LLW	Regionalized 2, 4, Centralized 2 and 4	None	No Action, Decentralized, Regionalized 1-5
	TRUW	No Action, Decentralized, Regionalized 1 and 2	No Action, Decentralized, Regionalized 1 and 2	None
	HW	Regionalized 1	None	None
Nevada Test Site, NV	LLMW	Decentralized	No Action	Decentralized, Regionalized 1-4
	LLW	None	None	No Action, Decentralized, Regionalized 1-5, 7, Centralized 2 and 4
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Oak Ridge Reservation, TN	LLMW	All	No Action	Decentralized, Regionalized 1,2,4
	LLW	Regionalized 2, 4, 5, Centralized 3 and 4	None	No Action, Decentralized, Regionalized 1-5
	TRUW	No Action, Decentralized, Regionalized 1 and 2	No Action, Decentralized, Regionalized 1 and 2	None
	HW	No Action, Decentralized, Regionalized 1 and 2	None	None

Table 11.1-1. Major Waste Management Sites and Alternatives[a]—Continued

Sites	Waste Types	Alternatives: Treatment	Storage	Disposal
Paducah Gaseous Diffusion Plant, KY	LLMW	No Action, Decentralized, and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2	None	Decentralized, Regionalized 1 and 2
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Pantex Plant, TX	LLMW	Decentralized and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2	None	Decentralized, Regionalized 1 and 2
Portsmouth Gaseous Diffusion Plant, OH	LLMW	Decentralized, Regionalized 1,2, and 3	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2, 4, Centralized 3 and 4	None	Decentralized, Regionalized 1 and 2
Rocky Flats Environmental Technology Site, CO	LLMW	No Action, Decentralized, Regionalized 1 and 2	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2, 4, Centralized 3 and 4	None	Decentralized, Regionalized 1 and 2
	TRUW	No Action, Decentralized, Regionalized 1 and 2	No Action, Decentralized, Regionalized 1 and 2	None
Sandia National Laboratories, NM	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Savannah River Site, SC	LLMW	All	No Action	All
	LLW	Regionalized 2, 4–7, Centralized 3 and 4	None	No Action, Decentralized, Regionalized 1–7
	TRUW	No Action, Decentralized, Regionalized 1–3	No Action, Decentralized, Regionalized 1–3	None
	HLW	None	All	None
	HW	Decentralized and Regionalized 1	None	None
Waste Isolation Pilot Plant, NM	TRUW	Centralized	None	Decentralized, Regionalized 1–3, Centralized
West Valley Demonstration Project, NY	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
	TRUW	No Action and Decentralized	No Action and Decentralized	None
	HLW	None	No Action and Decentralized	None

Notes: LLMW = low-level mixed waste; LLW = low-level waste; TRUW = transuranic waste; HLW = high-level waste; HW = hazardous waste.
[a] The alternatives listed do not include onsite LLMW wastewater treatment facilities and onsite minimum LLW treatment facilities that would occur under all the LLMW and LLW alternatives.

Table 11.1-2. Preferred Alternatives for Major Waste Management Sites

Waste Type	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR
LLMW	Treatment	D	R1[a]	D	R1	R4	D	D	R1[a]	R2
	Disposal[b]	R	R	R	R	R	R	R	R	R
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	R3	R3
	Disposal[b]	R	R	R	R	R	R	R	R	R
TRUW	Treatment/ Storage	D			D	R3	D	D	D	R1
HLW	Storage				D	D				
HW	Treatment	N	-	-	N	N	N	N	-	N

Waste Type	Decision	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	WIPP
LLMW	Treatment	R2	D	D	D	D	R1	R1[a]	
	Disposal[b]	R	R	R	R	R	R	R	
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	
	Disposal[b]	R	R	R	R	R	R	R	
TRUW	Treatment/ Storage	D	**		D	R1	R1	D	*
HLW	Storage						D	D	
HW	Treatment	-	N	-	-	N	N	-	

Notes: N = No Action; D = Decentralized; R, R1, R2, R3, R4 = Regionalized Alternatives; - = site not analyzed as a major generating site; * = no impacts from treatment/storage; ** = although not analyzed in the WM PEIS, the very small amount of TRUW at Pantex would be shipped to LANL for treatment and storage. A blank cell indicates that the waste type is not found at the site. Cumulative impacts for the preferred alternatives at each site are based on alternatives in this table.

[a] Wastes from these sites (BNL, NTS, and WVDP) are shipped offsite to regional treatment centers.

[b] DOE prefers to further narrow its configuration of LLMW and LLW disposal sites to 2-3 sites. The selection of sites would be made following consultation with regulatory authorities, state and tribal governments, and other interested stakeholders. Impacts for disposal will vary depending on final selection of sites. Cumulative impact estimates use alternatives with maximum potential impacts. For LLMW disposal, Alternative R2 was the basis for INEL, LANL, ORR, and SRS; Alternative R3 was the basis for NTS; and the Alternative C was the basis for Hanford. For LLW disposal, Alternative R3 was used for INEL, LANL, ORR, and SRS; Alternative C1 was used for Hanford; and Alternative C2 was used for NTS.

impacts expected for indefinite storage of LLMW can be found in Section 6.16 of Chapter 6. A brief discussion of the longer term effects of storage of TRUW can be found in Section 8.3.1 of Chapter 8, with a more detailed assessment in the WIPP SEIS-II (DOE, 1996m).

It should also be noted that the No Action Alternative for HLW does not provide enough canister storage for all of the canisters that would be produced after treatment of HLW. Provision of adequate storage capacity would lead to costs and impacts as great as shown for the other HLW alternatives. A discussion of the assumptions made to address this shortage of storage capacity in the HLW analyses is contained in Section 9.3.1 of Chapter 9.

11.2 Cumulative Impacts

The cumulative impacts analysis considers the following impact areas for existing conditions (incorporating past impacts), combined waste management impacts, and impacts of reasonably foreseeable future actions:

Human Health Risk

- Collective radiation dose and cancer risk for the public (over the 10-year period of operations)
- Annual radiation dose for the hypothetical maximally exposed offsite individual
- Collective radiation dose and cancer risk for the worker population at the site (over the 10-year period of operations)
- Number of truck or rail shipments of radioactive waste types to and from each site and the contributions to dose to a maximally exposed individual located 30 m from the site gate

Environmental Quality

- Air quality exceedances (list of those emissions that could exceed air quality standards or guidelines for combined waste management and future actions)
- Groundwater quality exceedances (list of those contaminants that could exceed drinking water standards for combined waste management LLMW and LLW disposal actions and other future actions)

Resource and Infrastructure Requirements

- Land requirements (presented as the percent of suitable land needed for combined waste management and future actions). For purposes of the cumulative impact analysis, the amount of suitable land at each site was based on the total amount of land that could be developed in any way and was defined as the total area of the site minus any areas that are undevelopable because of environmental or other restrictions (e.g., designated wetlands, ecological reserves, and buffer areas). This definition was used for the cumulative impact analysis to enable consideration of the impacts of past and present activities on land availability. In contrast, waste-specific analyses presented in Chapters 6 through 10 were based primarily on land that has been set aside specifically for waste management purposes.
- Percent of current water supply (presented as the percent of existing capacity needed for combined waste management and future actions)
- Percent of current wastewater treatment capacity (presented as the percent of existing capacity needed for combined waste management and future actions)
- Percent of current power capacity (presented as the percent of existing capacity needed for combined waste management and future actions)

Socioeconomic Factors

- Site employment (average number of people employed on an annual basis during operations)

Cumulative impacts for each of the 17 major sites were evaluated by adding the combined impacts of waste management alternatives to the impacts of other past, present, and reasonably foreseeable actions at the site and in the region (largely actions that DOE is considering for other programs). These include actions related to production and management of nuclear materials, management of nuclear fuel, research and development activities, and defense programs as described in various EAs and EISs (Table 11.2–1). Health risks from past DOE operations are not included in the cumulative impact analysis because the data are not currently available for most sites. Although dose reconstruction studies were conducted at several DOE sites, studies have not been conducted at most of the DOE sites.

Section 1.8 describes the relationship between the WM PEIS and other DOE NEPA activities. These other reasonably foreseeable future actions are ones for which an EA or an EIS has been prepared. Activities for which an EIS has not been prepared or for which a permit has not been issued are not considered to be reasonably foreseeable. Where decisions have not been made regarding the preferred alternatives for a

Table 11.2-1. Source Documents Describing Other Activities Included in the Cumulative Impact Analysis

Title	Applicable Sites	Reference
Final Environmental Impact Statement, Waste Isolation Pilot Plant	WIPP	DOE (1980)
Final Supplemental Environmental Impact Statement, Waste Isolation Pilot Plant	WIPP	DOE (1990b)
Final Environmental Impact Statement, Defense Waste Processing Facility	SRS	DOE (1982b)
Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility	SRS	DOE (1994h)
Savannah River Site Waste Management Final Environmental Impact Statement	SRS	DOE (1995c)
Final Environmental Impact Statement, Long-Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley	WVDP	DOE (1982a)
Final Environmental Impact Statement, Management of Spent Nuclear Fuel from the K Basins at the Hanford Site, Richland, Washington	Hanford	DOE (1996a)
Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement	Hanford, INEL, SRS	DOE (1995d)
Storage and Disposition of Weapons-Usable Fissile Materials, Draft Environmental Impact Statement	Hanford, INEL, NTS, ORR, Pantex, SRS	DOE (1996b)
Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement	LANL, SNL-NM	DOE (1996c)
Dual Axis Radiographic Hydrodynamic Test Facility, Final Environmental Impact Statement	LANL	DOE (1995e)
Final Environmental Impact Statement for the Tank Waste Remediation System	Hanford	DOE (1996d)
Plutonium Finishing Plant Stabilization Final Environmental Impact Statement	Hanford	DOE (1996e)
Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management	LLNL, LANL, NTS, ORR, Pantex, SRS	DOE (1996f)
The Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada	NTS	DOE (1996g)
Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Services Center	WVDP	DOE & NY ERDA (1996h)
Final F-Canyon Plutonium Solutions Environmental Impact Statement	SRS	DOE (1994g)
Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee	ORR	DOE (1994i)

Table 11.2–1. Source Documents Describing Other Activities Included in the Cumulative Impact Analysis—Continued

Title	Applicable Sites	Reference
Final Environmental Impact Statement for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories	LLNL, SNL-CA	DOE (1992b)
Disposition of Surplus Highly Enriched Uranium, Draft Environmental Impact Statement	ORR, SRS	DOE (1995f)
Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling	SRS	DOE (1995a)
Draft Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components	Pantex	DOE (1996i)
Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan	Hanford	DOE (1996j)
Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Cruiser, Ohio Class and Los Angeles Class Naval Nuclear Plants	Hanford	Navy (1996)
Nonnuclear Consolidation Environmental Assessment	LANL, ORR, RFETS, SNL-NM, SRS	DOE (1993)
Proposed 7-GeV Advanced Photon Source Environmental Assessment	ANL-E	DOE (1990c)
Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories	SNL-NM	DOE (1996k)

Notes: WIPP = Waste Isolation Pilot Plant; SRS = Savannah River Site; WVDP = West Valley Demonstration Project; INEL = Idaho National Engineering Laboratory; NTS = Nevada Test Site; ORR = Oak Ridge Reservation; LANL = Los Alamos National Laboratory; SNL-NM = Sandia National Laboratories (New Mexico); LLNL = Lawrence Livermore National Laboratory.

reasonably foreseeable action, the cumulative impacts analysis considers the range of impacts of those alternatives. Otherwise, only the impacts of the preferred alternative are included in the cumulative impact analysis.

No assumptions are made regarding future baseline conditions at each of the major sites that could potentially reduce impacts, such as cessation of certain ongoing operations that would reduce current levels of radioactive releases. If the preferred alternative of a sitewide EIS identifies changes in site operations, these changes are considered additional foreseeable future actions.

A number of other simplifying assumptions were made to estimate cumulative impacts regarding timing, site location, and consistency of analytical methods. Other existing or planned actions at each site were assumed to occur over the entire 10-year period of waste management operations. These actions were assumed to be collocated with waste management facilities and therefore assumed to affect the same population and maximally exposed individual. For the assessment of site-specific transportation effects, if shipment contents were not specifically stated in reference documents, it was assumed these contents consisted of HLW, which would result in the highest dose. In addition, some double-counting of impacts occurred in cases where waste management actions would replace some existing activities (e.g., existing shipments of radioactive materials) rather than being added to those activities. These assumptions result in conservative analyses that overestimate actual cumulative impacts. These simplifying assumptions also may result in some differences in estimated impacts between the WM PEIS and site-specific documents. In addition, these simplifying assumptions and other assumptions used in performing calculations can result in some uncertainty regarding projected cumulative impacts. The cumulative impact analysis in the WM PEIS should be used only for evaluating the WM PEIS alternatives; any site-specific analysis is considered to supersede the WM PEIS cumulative analysis for that site.

The impacts of future environmental restoration activities at each of the major waste management sites have been incorporated into the cumulative impact analysis and referenced in all cases where that information is available in existing NEPA documents or in Comprehensive Environmental Response, Compensation, and Liability Act/Resource Conservation and Recovery Act (CERCLA/RCRA) program documents. At some sites, the impacts of future environmental restoration actions cannot be determined because of insufficient characterization of the contamination or because proposals for particular actions are not yet ripe. For these sites, the volumes of environmental restoration wastes are presented in this chapter, and the likely significance of impacts is discussed based on past environmental restoration activities at the site. Cumulative impacts of environmental restoration activities at these sites would be fully analyzed in later site-specific NEPA reviews or in CERCLA/RCRA program documents. Descriptions of the environmental restoration program at each of the major waste management sites are provided in Appendix B. A quantitative evaluation of Greater-than-Class-C waste and special-case waste is not included in the cumulative impact assessment because plans for these activities have not been sufficiently developed (see Sections 1.5.6 and 7.1.1) but would be the subject of site-specific and project-specific evaluations.

The following cumulative impact analyses focus on several key impact categories that include the human health risks to the offsite population and a hypothetical maximally exposed individual as a result of radioactive releases, potential air quality and water quality exceedances, resource and onsite infrastructure impacts, and changes in site employment. The human health risks to the offsite population are reported as collective exposures and risks for the 10-year period of operation, while the dose to the maximally exposed individual is reported as an annual value. Annual exposures are used for the maximally exposed individual because annual exposures facilitate a direct comparison to the U.S. Environmental Protection Agency's (EPA's) standard of a 10-millirem exposure per year to a maximally exposed individual from atmospheric releases and DOE's standard of a 100-millirem exposure per year to a maximally exposed individual from all pathways. A cumulative impacts table containing the impact categories and the major elements comprising the cumulative impacts is presented for each of the major sites. These elements include the existing conditions at the site (which incorporate residual impacts from past actions), the combined impacts of the waste management alternatives (maximum and minimum alternatives and preferred alternatives) analyzed in this WM PEIS, and the impacts of other reasonably foreseeable future actions as described in recent EISs by DOE and others. The number of impact categories addressed as part of the cumulative impact analysis for each of the major sites is limited both by the availability of information (e.g., estimated chemical cancer incidences as a result of chemical releases are not reported for all other potential actions at a site) and by differences in assessment methodologies.

The following sections identify and discuss the combined and cumulative impacts for each of the major sites, followed by a discussion of combined and cumulative transportation impacts.

11.3 Argonne National Laboratory-East

Argonne National Laboratory-East (ANL-E) conducts programs in basic energy and related sciences. The existing environmental conditions at ANL-E resulting from these ongoing activities are described in Chapter 4.

11.3.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at ANL-E. Table 11.3–1 lists the minimum and maximum combined impacts of the waste management alternatives for ANL-E. Generally, the most adverse impacts that could occur at ANL-E and in the region would result from the Decentralized Alternatives, which involve construction of treatment and disposal facilities for ANL-E to manage its own waste. The least adverse impacts generally would result from the Regionalized and Centralized Alternatives, for which ANL-E would package and ship its waste for offsite treatment and disposal. The impacts of

Table 11.3–1. Argonne National Laboratory-East Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.2E–03	N	5.2E–01	R1-C	5.9E–07	N	2.6E–04	R1-C	6.2E–09	N	6.2E–06
Low Level[a]	N	4.7E–03	D-C5	5.0E–03	N	2.3E–06	D-C5	2.5E–06	--	--	--	--
Transuranic	N	1.2E–03	D	4.0E–03	N	6.2E–07	D	2.0E–06	N	3.8E–10	R1-C	2.9E–09
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**7.1E–03**		**5.3E–01**		**3.5E–06**		**2.6E–04**		**6.6E–09**		**6.2E–06**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	6.5E–09	N	2.8E–06	R1-C	3.3E–12	N	1.4E–09	R1-C	3.9E–14	N	3.9E–11
Low Level[a]	N	2.6E–08	D-C5	2.8E–08	N	1.3E–11	D-C5	1.4E–11	--	--	--	--
Transuranic	N	6.9E–09	D	2.2E–08	N	3.5E–12	D	1.1E–11	D,N	0.0E+00	R1-C	1.3E–14
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.9E–08**		**2.9E–06**		**2.0E–11**		**1.4E–09**		**3.9E–14**		**3.9E–11**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10/yr)				Radiation Dose From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R1-C	20 / 20	N	0.0E+00	R1-C	3.20E-07	N	0.0E+00	R1-C	3.20E-07
Low Level[a]	D	450 / 180	N	1,060 / 400	D	7.20E-06	N	1.70E-05	D	2.90E-06	N	6.40E-06
Transuranic	N	0 / 0	D	590 / 300	N	0.0E+00	D	7.10E-05	N	0.0E+00	D	7.40E-05
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**450 / 180**		**1,670 / 720**		**7.2E–06**		**8.8E–05**		**2.9E–06**		**8.1E–05**

Table 11.3-1. Argonne National Laboratory-East Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.7E-06	N	2.5E-03	R1-C	8.6E-10	N	1.2E-06	R1-C	1.3E-10	N	1.3E-07
Low Level[a]	N	1.9E-05	D-C5	2.0E-05	N	9.3E-09	D-C5	9.8E-09	--	--	--	--
Transuranic	N	6.5E-06	D	2.1E-05	N	3.2E-09	D	1.0E-08	N	8.0E-12	R1-C	6.0E-11
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		2.7E-05		2.5E-03		1.3E-08		1.2E-06		1.3E-10		1.3E-07

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Types of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	N	0.6	D	2.3
Low Level	All/None	All/None	All	None	All	None	N	0.8	D	4.1
Transuranic	All/None	All/None	--	--	--	--	N	0	D	2.7
High Level[b]	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--
Total	None[d]	None		None		None		1.4		9.1

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	1,336	D	2,825	N	37	D	919	R1-C	0.01	D	0.31
Low Level	N	1,875	D	12,053	N	640	D	1,014	N	0.11	D	1.70
Transuranic	N	921	D	4,769	N	921	D	1,509	N	0.09	D	0.44
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		4,132		19,647		1,598		3,442		0.21		2.45

Table 11.3–1. Argonne National Laboratory-East Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.00	D-C	<0.01	N	0.00	D-C	<0.01	N	22	D	59
Low Level	N,R1-C5	0.00	D	0.01	All	0.00	All	0.00	R1-C5	106	D	389
Transuranic	N	0.00	D-C	0.01	All	0.00	All	0.00	N	104	R2-C	334
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.00**		**0.02**		**0.00**		**<0.01**		**232**		**782**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (c); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences.

[b] Argonne National Laboratory-East does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

preferred alternatives at ANL-E are below the impacts of the maximum combined waste management alternatives at the site.

11.3.2 CUMULATIVE IMPACTS

Aside from continuing operations, the waste management activities considered in this PEIS, and environmental restoration activities, DOE has no other actions planned at ANL-E. The Advanced Photon Source (APS), an already-constructed accelerator facility (DOE, 1990c), recently became operational; its operation is considered a reasonably foreseeable future action for the purposes of this analysis. No other DOE or non-DOE actions are planned in the ANL-E region that would contribute to the cumulative impact of the alternatives.

The environmental restoration program at ANL-E will address cleanup of an estimated 148,000 m^3 of contaminated media and facilities (140,000 m^3, 8,800 m^3, and 190 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities have had no significant adverse environmental impacts based on the NEPA reviews completed to date. Project-specific environmental evaluations that consider cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

Table 11.3–2 identifies the range of cumulative impacts that could occur at ANL-E. As identified in Table 11.3–2, the minimum and maximum annual radioactive releases from waste management and other future actions (including transportation) would not measurably increase the current levels of risks from radioactive releases. ANL-E would continue to be below the EPA standard of 10 millirems per year to the maximally exposed offsite individual.

ANL-E is in a nonattainment region for particulates and for ozone. While the expected atmospheric emissions of particulates and ozone-producing contaminants under the alternatives would increase the levels of these emissions, the increases would be below the regulated levels in the nonattainment region. Disposal of LLMW or LLW at ANL-E under any alternative are not expected to result in any exceedances of drinking water standards in groundwater.

Table 11.3-2. Argonne National Laboratory-East Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts: Minimum	Combined Waste Management Impacts: Maximum	Combined Waste Management Impacts: Preferred Alternative	Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]: Minimum[c]	Cumulative Impacts[b]: Maximum[d]	Cumulative Impacts[b]: Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.7E+02	7.1E-03	5.3E-01	4.20E-02	not reported	1.7E+02	1.7E+02	1.7E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0		~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	8.5E-03	3.9E-06	2.9E-04	2.3E-05	6.0E+00	6.0E+00	6.0E+00	6.0E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	4.3E+01	7.9E+01	2.1E+02	1.0E+02	not reported	1.2E+02	2.5E+02	1.4E+02
Number of cancer fatalities from collective dose	(1)	~0	~0	~0	~0		~0	1.0E-01	~0
Transportation Effects on Offsite Maximum Exposed Individual	(5)								
Number of truck shipments (10 yr)		1,080	450	1,670	1,660	0	1,530	2,750	2,740
Number of rail shipments (10 yr)		0	180	720	710	0	180	720	710
Annual dose (mrem) from truck transport		4.3E-01	7.2E-04	8.8E-03	8.83E-03	0.0E+00	4.3E-01	4.4E-01	4.4E-01
Annual dose (mrem) from rail transport		0.0E+00	2.9E-04	8.1E-03	8.06E-03	0.0E+00	2.9E-04	8.1E-03	8.1E-03
Resources and Infrastructure									
Land requirement (% of suitable area)		30%	0.09%	0.61%	0.43%	4.67%	35%	35%	35%
Water use (% of total capacity)		36%	0.23%	1.09%	0.54%	4.50%	41%	41%	41%
Wastewater production (% of treatment capacity)		60%	0.09%	0.19%	0.17%	4.40%	64%	65%	65%
Power demand (% current load)		96%	0.88%	10.21%	4.00%	142.00%	239%	248%	242%
Employment									
Number of site workers	(7)	4,670	86	247	132	300	5,056	5,217	5,102
Air Quality Exceedances	(8)	PM_{10}, ozone	None	None	None	None	PM_{10}, ozone	PM_{10}, ozone	PM_{10}, ozone
Groundwater Quality Exceedances	(9)	5 parameters exceeded	None	None	None	None	5 parameters exceeded	5 parameters exceeded	5 parameters exceeded

[a] Other reasonably foreseeable future actions planned by DOE at ANL include operation of the recently constructed Advanced Photon Source (DOE, 1990c).
[b] Sum of impacts of existing operations, combined waste management impact, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5E-04 cancer fatalities per person-rem. Calculated values less than 1E-01 are reported as approximately zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point. Excludes radon-220, which is not subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) limits. Exposure from existing operations at ANL-E including radon-220 = 0.24 mrem.
(4) Includes both waste management and noninvolved workers. Assumes 4E-04 cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and is not an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in or be a substantial contributor to nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined actions would affect between 1 and 9 acres of land at ANL-E. This area is less than 1% of the total ANL-E site and less than 1% of the area available for waste management facilities. The increased demand for power under the maximum combined alternatives represents about 10% of current capacity, while the combined alternatives would not measurably change the current demand at ANL-E for water or wastewater treatment. Cumulatively, power demand would increase substantially as a result of operation of the new APS facility.

The combined waste management alternatives could add up to 247 jobs at ANL-E, or an approximately 5% increase at the maximum. The maximum increase in jobs at ANL-E would not be expected to result in offsite community infrastructure or institutional impacts because of the extremely large population and employment base of the ANL-E region.

11.4 Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) would continue in the future to conduct programs in basic and applied research in the physical, biomedical, and environmental sciences and selected energy technologies. The existing environmental conditions at BNL resulting from these ongoing activities are described in Chapter 4.

11.4.1 Combined Waste Management Impacts

DOE considered the management of LLMW[1] and LLW at BNL. Table 11.4–1 lists the minimum and maximum combined impacts of the waste management alternatives for BNL. The most adverse impacts at BNL and in the BNL region would result from the decentralized alternatives, for which treatment and disposal facilities would be constructed for BNL to manage its own waste. The least adverse impacts at BNL and in the BNL region generally would result from the regionalized and centralized alternatives for which BNL would package and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at BNL are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

[1] Analysis of LLMW impacts at BNL assumed an inventory of 85 cubic meters and 20-year projected volume of 110 cubic meters. Updated information from the site indicates that there are 10 cubic meters in inventory and a projected 20-year volume of 20-cubic meters. Therefore, LLMW impacts reported for BNL are expected to be conservative.

Table 11.4–1. Brookhaven National Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.0E–04	N	2.3E–01	R1-C	5.2E–08	N	1.1E–04	R1-C	9.0E–09	N	8.0E–06
Low Level[a]	D	1.9E–05	R1-C5	4.7E–03	D	9.7E–09	R1-C5	2.3E–06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.2E–04**		**2.6E–01**		**6.0E–08**		**1.1E–04**		**9.0E–09**		**8.0E–06**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.4E–09	N	3.0E–06	R1-C	7.0E–13	N	1.5E–09	R1-C	1.5E–13	N	1.3E–10
Low Level[a]	D	2.6E–10	R1-C5	6.2E–08	D	1.3E–13	R1-C5	3.1E–11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.7E–09**		**3.1E–06**		**8.3E–13**		**1.5E–09**		**1.5E–13**		**1.3E–10**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D,N	0 / 0	R1-C	20 / 20	D,N	0.0E+00	R1-C	3.20E–07	D,N	0.0E+00	R1-C	3.20E–07
Low Level	D	0 / 0	N / N, R4,C3, C4	1,360 / 520	D	0.0E+00	N	2.18E–05	D	0.0E+00	N,R4, C3, C4	8.32E–06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**1,380 / 540**		**0.0E+00**		**2.2E–05**		**0.0E+00**		**8.6E–06**

Table 11.4-1. Brookhaven National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	6.4E-07	N	1.4E-03	R1-C	3.2E-10	N	7.0E-07	R1-C	3.1E-10	N	2.8E-07
Low Level[a]	D	4.8E-08	R1-C5	2.4E-05	D	2.4E-11	R1-C5	1.2E-08	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**6.9E-07**		**1.6E-03**		**3.4E-10**		**7.1E-07**		**3.1E-10**		**2.8E-07**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R1-C	0.0	D	1.6
Low Level	N,R1-C5/None	D/NO_2	All	None	All	None	N,R1-C5	1.2	D	2.8
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**NO_2**		**None**		**None**		**1.2**		**4.4**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	42	D	2,083	R1-C	42	D	370	R1-C	0.06	N	0.23
Low Level	N,R1-C5	1,258	D	8,000	N,R1-C5	441	D	865	N,R1-C5	0.12	D	1.10
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1,300**		**10,083**		**483**		**1,235**		**0.18**		**1.33**

Table 11.4-1. Brookhaven National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,R1-C	0.00	D	0.01	All	0.00	All	0.00	R1-C	8	D	84
Low Level	N,R1-C5	<0.01	D	0.02	N,R1-C5	<0.01	D	0.01	N,R1-C5	111	D	230
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		0.00		0.03		0.00		0.01		119		314

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Brookhaven National Laboratory does not have transuranic or high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives. Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

11.4.2 Cumulative Impacts

Aside from continuation of existing operations, the waste management activities considered in this PEIS, and environmental restoration activities, DOE has no other actions planned at BNL. No other DOE or non-DOE actions are planned in the BNL region that would contribute to the cumulative impacts of waste management alternatives.

The environmental restoration program at BNL will address cleanup of an estimated 139,800 m^3 of contaminated media and facilities (19,000 m^3 and 120,800 m^3 of LLMW and LLW, respectively; see Appendix B). Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, no major changes are anticipated from ongoing environmental restoration activities, and any future impacts should be similar to those occurring under existing operations. Project-specific environmental evaluations that consider cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

Table 11.4–2 identifies the range of cumulative impacts that could result from the combined waste management alternatives and current operations and activities at BNL. As identified in Table 11.4–1, the maximum annual radioactive releases to the atmosphere from waste management activities (including transportation) would result in some increase in dose to the offsite population; however, BNL atmospheric releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

BNL is in a nonattainment region for ozone. While the expected atmospheric emissions of ozone-producing contaminants under the alternatives would increase the levels of ozone, the increases would be below the regulated levels in the nonattainment region. The maximum combined alternatives could result in exceedance of the air quality standard for NO_2. Mitigation would be required to maintain compliance should these alternatives be chosen. The combined preferred alternatives are not expected to result in an exceedance of the NO_2 standard. Disposal of LLMW or LLW at BNL under any alternative is not expected to result in any exceedances of drinking water standards in groundwater.

The combined actions would affect a maximum of 4 acres of land. This area is less than 1% of the total suitable acreage at BNL and less than 1% of the area available for waste management facilities. Onsite infrastructure demands for water and power and the generation of wastewater would not measurably

Table 11.4-2. Brookhaven National Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts: Minimum	Combined Waste Management Impacts: Maximum	Combined Waste Management Impacts: Preferred Alternative	Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]: Minimum[c]	Cumulative Impacts[b]: Maximum[d]	Cumulative Impacts[b]: Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	2.7E+01	1.2E-04	2.6E-01	4.8E-03	--	2.7E+01	2.7E+01	2.7E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	--	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.1E-01	1.7E-07	3.1E-04	6.3E-06	--	1.1E-01	1.1E-01	1.1E-01
Worker Population									
Collective dose, 10 years (person-rem)	(4)	NA	9.9E+01	1.9E+02	9.9E+01	--	9.9E+01	1.9E+02	9.9E+01
Number of cancer fatalities from collective dose	(1)	NA	~0	~0	~0	--	~0	~0	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	80	0	1,380	1,370	--	80	1,460	1,370
Number of rail shipments (10 yr)		0	0	540	530	--	0	540	530
Annual dose (mrem) from truck transport		3.2E-02	0.0E+00	2.2E-03	2.23E-03	--	3.2E-02	3.4E-02	2.2E-03
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	8.6E-04	8.52E-04	--	0.0E+00	8.6E-04	8.5E-04
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	36%	0.03%	0.10%	0.03%	--	36%	36%	36%
Water use (% of total capacity)		75%	0.02%	0.17%	0.02%	--	75%	75%	75%
Wastewater production (% of treatment capacity)		43%	0.02%	0.05%	0.02%	--	44%	44%	44%
Power demand (% current load)		74%	0.38%	2.83%	0.38%	--	75%	77%	75%
Employment									
Number of site workers	(7)	3,557	41	105	41	--	3,598	3,744	3,598
Air Quality Exceedances	(8)	Ozone	None	NO_2	None	--	Ozone	Ozone, NO_2	Ozone
Groundwater Quality Exceedances	(9)	8 parameters exceeded	None	None	None	--	8 parameters exceeded	8 parameters exceeded	8 parameters exceeded

[a] Aside from continuation of existing operations, waste management activities, and environmental restoration actions, no other future actions are planned by DOE at BNL.
[b] Sum of impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5E-04 cancer fatalities per person-rem. Calculated values less than 1E-01 are reported as approximately zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both waste management and noninvolved workers. Assumes 4E-04 cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and is not an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in or be a substantial contributor to nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

increase as a result of the combined alternatives. The combined alternatives could add up to 105 jobs at BNL, or an approximately 3% increase at the maximum, which would not affect offsite community infrastructures or institutions.

11.5 Fernald Environmental Management Project

The Fernald Environmental Management Project (FEMP) will continue in the future to conduct site cleanup and support waste management and base service activities. The existing environmental conditions at FEMP resulting from these ongoing activities are described in Chapter 4.

11.5.1 Combined Waste Management Impacts

DOE considered the management of LLMW and LLW at FEMP. Table 11.5–1 lists the minimum and maximum impacts of the alternatives for FEMP. The most adverse impacts at FEMP and in the FEMP region would occur as a result of Regionalized Alternatives for which treatment and disposal facilities would be constructed for FEMP to manage its own waste, as well as the treatment of LLMW from other sites.

Other Regionalized or Centralized Alternatives for which FEMP would only prepare and package waste for offsite treatment and disposal would result in the least adverse impacts. For most impact categories, the combined impacts of the preferred alternatives at FEMP are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.5.2 Cumulative Impacts

Aside from continuation of existing operations, the waste management activities considered in this PEIS, and future environmental restoration activities, DOE has no other actions planned at FEMP. No other DOE or non-DOE actions are planned in the FEMP region that would contribute to the cumulative impacts of waste management alternatives. The environmental impacts of environmental restoration activities have been presented in various CERCLA documents (DOE 1994j, k; 1995g, h; 1996l).

Table 11.5–1. Fernald Environmental Management Project Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	2.9E–04	R1	1.4E+00	R2-C	1.4E–07	R1	7.0E–04	R2-C	9.2E–08	N	3.3E–05
Low Level[a]	--	--	R2	4.6E+02	--	--	R2	2.3E–01	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.9E–04**		**4.6E+02**		**1.4E–07**		**2.3E–01**		**9.2E–08**		**3.3E–05**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	5.4E–09	R1	2.6E–05	R2-C	2.7E–12	R1	1.3E–08	R2-C	2.9E–12	N	1.1E–09
Low Level[a]	--	--	R2	8.8E–03	--	--	R2	4.4E–06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.4E–09**		**8.8E–03**		**2.7E–12**		**4.4E–06**		**2.9E–12**		**1.1E–09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D	0 / 0	R1	1,060 / 410	N,D	0.0E+00	R1	1.70E–05	N,D	0.0E+00	R1	6.60E–06
Low Level[a]	--	--	R2	910 / 400	--	--	R2	1.50E–05	--	--	R2	6.40E–06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**1,970 / 810**		**0.0E+00**		**3.25E–05**		**0.0E+00**		**1.3E–05**

Table 11.5–1. Fernald Environmental Management Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	2.1E-06	R1	9.4E-03	R2-C	1.1E-09	R1	4.7E-06	R2-C	6.4E-09	N	2.3E-06
Low Level[a]	--	--	R2	1.0E+00	--	--	R2	5.2E-04	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.1E-06**		**1.0E+00**		**1.1E-09**		**5.2E-04**		**6.4E-09**		**2.3E-06**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	--	--	D, R1	U-238	R2-C	1.4	R1	12.3
Low Level[a]	R2/None	R2/None	--	--	--	--	N,D,R1, R3-C5	0.0	R2	3.9
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	None[c]	None		None				**1.4**		**16.2**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	2,104	R1	23,556	N	1,013	R1	4,630	R2-C	0.76	N	2.65
Low Level[a]	--	--	R2	5,254	--	--	R2	2,403	--	--	R2	0.50
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2,104**		**28,810**		**1,013**		**7,033**		**0.76**		**3.15**

Table 11.5-1. Fernald Environmental Management Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.01	R1	0.07	N,R2-C	0.01	R1	0.04	N	107	R1	584
Low Level[a]	--	--	R2	0.04	--	--	R2	0.02	N,D,R1, R3-C5	0	R2	312
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.01**		**0.11**		**0.01**		**0.06**		**107**		**896**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] The Fernald Environmental Management Project does not have transuranic or high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives. Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.5–2 identifies the range of cumulative impacts that could result from the combined waste management alternatives, current activities, and future actions at FEMP. However, the radiological effects of environmental restoration activities at FEMP are not included in this analysis because of differences in analytical approaches. As identified in Table 11.5–1, the maximum annual radioactive releases to the atmosphere from combined waste management activities (including transportation) would result in some increase in dose to the offsite population; however, atmospheric radioactive releases from existing operations and waste management activities would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite. FEMP is in a nonattainment region for ozone. While the expected atmospheric emissions of ozone-producing contaminants under the combined alternatives would increase the levels of ozone, the increases would be below the regulated levels in the nonattainment region.

The combined actions could affect a maximum of 16 acres of land. This area is less than 2% of the total suitable acreage at FEMP and 6% of the area available for waste management facilities. Other actions could affect 208 acres of the FEMP site. Onsite cumulative demands for water, wastewater treatment, and power could exceed existing capacities. The combined alternatives could add up to 328 jobs at FEMP, or a maximum increase of about 15% over existing employment. The maximum increase in employment is not expected to affect offsite community infrastructures or institutions because of the current population and employment base in the FEMP region.

Disposal of LLMW at FEMP under the Decentralized Alternative and Regionalized Alternative 1 could result in exceedances of drinking water standards in groundwater for U-238. Mitigation could be required to maintain compliance with drinking water standards should either of these alternatives be selected. No disposal of LLMW at FEMP would occur under the preferred alternative.

11.6 Hanford Site

The Hanford Site would continue in the future to conduct programs for waste disposal technologies and cleanup of site contamination. The existing environmental conditions at the Hanford Site resulting from these ongoing activities are described in Chapter 4.

Table 11.5-2. Fernald Environmental Management Project Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts: Minimum	Combined Waste Management Impacts: Maximum	Combined Waste Management Impacts: Preferred Alternative	Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]: Minimum[c]	Cumulative Impacts[b]: Maximum[d]	Cumulative Impacts[b]: Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.3E+01	2.90E-04	4.60E+02	5.20E-02	Not available	1.30E+01	4.73E+02	1.31E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	2.30E-01	~0	Not available	~0	2.37E-01	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	2.10E-03	5.40E-07	8.80E-01	9.70E-05	Not available	2.10E-03	8.82E-01	2.20E-03
Worker Population									
Collective dose, 10 years (person-rem)	(4)	6.75E+02	6.30E-01	8.47E+01	7.30E-01	Not available	6.76E+02	7.60E+02	6.76E+02
Number of cancer fatalities from collective dose	(1)	2.70E-01	~0	~0	~0	Not available	2.70E-01	3.04E-01	2.70E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	4,460	0	1,970	110	Not available	4,460	6,430	4,570
Number of rail shipments (10 yr)		0	0	810	50	Not available	0	810	50
Annual dose (mrem) from truck transport		1.8E+00	0.0E+00	3.2E-03	1.80E-04	Not available	1.8E+00	1.8E+00	1.8E+00
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.3E-03	8.10E-05	Not available	0.0E+00	1.3E-03	8.1E-05
Resources and Infrastructure									
Land requirement (% of suitable area)		32%	0.16%	1.89%	0.99%	24.33%	57%	58%	57%
Water use (% of total capacity)		25%	0.13%	1.80%	1.10%	2,550%	2,575%	2,577%	2,576%
Wastewater production (% of treatment capacity)		96%	0.04%	0.31%	0.12%	9.52%	106%	106%	106%
Power demand (% current load)		91%	2.30%	9.55%	6.55%	6.00%	99%	106%	103%
Employment									
Number of site workers	(7)	2,124	38	328	134	0	2,162	2,452	2,258
Air Quality Exceedances	(8)	Ozone	None	None	None	None	Ozone	Ozone	Ozone
Groundwater Quality Exceedances	(9)	11 parameters exceeded	None	U-238	None	None	11 parameters exceeded	11 parameters exceeded	11 parameters exceeded

[a] Aside from waste management and environmental restoration activities, no other future actions are planned by DOE at FEMP. The impacts of environmental restoration activities have been presented in DOE 1994j, 1994k, 1995g, 1995h, 1996. In some cases, impacts were not presented in a manner that allowed addition to this table.
[b] Sum of impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based in DOE (1994a), which contains releases for the year 1992. Excludes radon-220, which is not subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) limits. Exposure from existing operations at FEMP including radon-220 = 51 mrem.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

11.6.1 COMBINED WASTE MANAGEMENT IMPACTS

DOE considered the management of LLMW, LLW, TRUW, HLW, and HW at the Hanford Site. Table 11.6–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for the Hanford Site. The most adverse impacts at the Hanford Site and in the Hanford Site region would occur as a result of some Regionalized and Centralized Alternatives for which treatment and disposal facilities would be constructed for the Hanford Site to manage its own waste and accept offsite LLMW and LLW for treatment and disposal, offsite TRUW for treatment, and offsite HLW canisters for storage. The least adverse impacts at Hanford and in the Hanford region generally would result from the No Action, Decentralized, and some Regionalized Alternatives for which the Hanford Site would be primarily responsible for its own waste, would package and ship its wastes for offsite treatment and disposal, or would only receive small quantities of waste from other sites for treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at Hanford are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.6.2 CUMULATIVE IMPACTS

Aside from continuation of existing operations and the waste management activities considered in this PEIS, there are a number of other actions planned or being undertaken by DOE at the Hanford Site that have been the subject of various recent EISs. These include the (1) development of a tank waste remediation system (DOE, 1996d); (2) management of spent nuclear fuel from K Basin (DOE, 1996a); (3) disposal of decommissioned, defueled Cruiser, Ohio Class, and Los Angeles Class Naval nuclear plants (Navy, 1996); (4) storage and disposition of weapons-usable fissile materials (DOE, 1996b); (5) plutonium finishing plant stabilization (DOE, 1996e); and (6) DOE spent nuclear fuel management (DOE, 1995d). The findings presented in these EISs are included in the cumulative impacts analysis presented here.

Future environmental restoration activities at the Hanford Site include the decontamination and decommissioning of facilities (including eight surplus reactors) and groundwater remediation. Environmental contamination is present in some areas of the Hanford Site, and major efforts will be required to achieve the current cleanup scenario. The current cleanup scenario for the Hanford Site is considered in the *Draft Hanford Remedial Action EIS and Comprehensive Land Use Plan* (DOE, 1996j). This document analyzes the potential environmental impacts associated with establishing future land-use objectives for the site. Impact analysis was performed by examining the consequences (primarily from

Table 11.6-1. Hanford Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1	2.7E+00	C	5.0E+01	R1	1.4E-03	C	2.5E-02	D,R1	1.1E-06	N,C	1.2E-05
Low Level[a]	N	8.3E-04	C5	1.5E+02	N	4.2E-07	C5	7.5E-02	--	--	--	--
Transuranic	N	1.5E-02	R2,3	3.3E+02	N	5.3E-06	R2,3	1.7E-01	N	2.6E-11	R1-R3	1.3E-10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	R1	4.3E-03
Total		2.7E+00		5.3E+02		1.4E-03		2.7E-01		1.1E-06		4.3E-03

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1	5.6E-05	C	1.0E-03	R1	2.8E-08	C	5.2E-07	R1	3.6E-11	N,C	4.1E-10
Low Level[a]	N	1.7E-08	C5	3.1E-03	N	8.6E-12	C5	1.5E-06	--	--	--	--
Transuranic	N	3.0E-07	R2,3	6.8E-03	N	1.5E-10	R2,3	3.4E-06	All	<9.9E-14	All	<9.9E-14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	R1	1.4E-07
Total		5.6E-05		1.1E-02		2.8E-08		5.4E-06		3.6E-11		1.4E-07

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck / Rail Shipments[b] (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	C	7,520 / 3,340	N	0.0E+00	C	1.2E-04	N	0.0E+00	C	5.4E-05
Low Level	D, R1-3	0 / 0	C1	242,730 / 91,440	D, R1-R3	0.0E+00	C1	3.9E-03	D, R1-R3	0.0E+00	C1	1.5E-03
Transuranic	N	0 / 0	R2-3	11,830 / 5,930	N	0.0E+00	R2-R3	1.8E-03	N	0.0E+00	R2-R3	1.8E-03
High Level	N, D, R1	15,000 / 3,000	C2	28,224 / 5,646	N, D, R1	6.0E-03	C2	1.1E-02	N, D, R1	1.2E-03	C2	2.3E-03
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		15,000 / 3,000		290,304 / 106,356		6.0E-03		1.7E-02		1.2E-03		5.7E-03

Waste Type	Noninvolved Worker Health Risks											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D,R1	1.0E-01	C	6.6E-01	R1	5.2E-05	C	3.3E-04	R1	6.5E-07	N,C	7.3E-06
Low Level[a]	N	3.0E-05	C5	1.9E+00	N	1.5E-08	C5	9.7E-04	--	--	--	--
Transuranic	N	7.0E-04	R2,R3	1.6E+01	N	3.5E-07	R2,R3	8.2E-03	N	1.6E-11	R1	7.9E-11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,D,R2	0.0E+00	R1	2.6E-03
Total		1.0E-01		1.8E+01		5.2E-05		9.5E-03		6.5E-07		2.6E-03

Table 11.6–1. Hanford Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	C/PM_{10}	--	--	D, R1, R2, R4, C	U-238 4 hazardous chemicals[c]	N	1.8	C	50.2
Low Level	All/None	All/None	--	--	N, D, R1-R6, C1, C3, C5	U-238	R7,C2	3.7	C5	86.4
Transuranic	All/None	All/None	--	--	--	--	N	0	R2,3	24.7
High Level	All/None	All/None	--	--	--	--	N	1	C	16.0
Hazardous	All/None	All/None	--	--	--	--	--	--	R1	1
Total	None[d]	NO_2, PM_{10}		None		U-238, 4 hazardous chemicals[e]		6.5		178.3

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	3,038	C	87,637	N	2,573	C	43,085	N	1.14	C	8.33
Low Level	R7,C2	6,887	C5	199,473	R7,C2	1,615	C5	101,650	R7,C2	0.83	C3	34.62
Transuranic	N	2,796	R2,3	64,729	N	2,796	R2,R3	15,519	N	0.30	R2, 3	3.60
High Level	N	3,200	D-C	8,000	N	3,200	D-C	8,000	N	0.06	C	0.10
Hazardous	--	--	R1	1,366	--	--	R1	933	--	--	R1	0.28
Total		15,921		361,205		10,184		169,187		2.33		46.93

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.09	C	1.66	N	0.05	C	0.76	N	260	C	3,968
Low Level	R7,C2	0.10	C5	3.34	R7,C2	0.04	C5	1.50	R7,C2	238	C5	7,961
Transuranic	N	0.10	R2,3	1.05	N	0.14	R2,3	0.39	N	287	R2,3	2,491
High Level	N	0.06	R2,C	0.14	N	0.04	D-C	0.08	N	826	C	1,734
Hazardous	--	--	R1	0.03	N,D,R2	0.00	R1	0.01	N,D	0	R1	70
Total		0.35		6.22		0.27		2.74		1,611		16,224

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; NO_2 = nitrogen dioxide; PM_{10} = particulate matter measuring less than 10 microns in diameter; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

[e] Hazardous chemicals that could exceed drinking water standards include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

remediation activities) of the actions determined necessary to achieve desired future land-use objectives. Site-specific decisions regarding remediation technologies and remediation activities would not be made based on the Draft Hanford Remedial Action EIS, but rather by a process specified in the Comprehensive Environmental Response Compensation and Liability Act of 1980 and the Resource Conservation and Recovery Act of 1976.

To facilitate the establishment of future land-use objectives, the Hanford Site was divided into four geographic areas: (1) Columbia River, (2) Reactors on the River, (3) Central Plateau, and (4) All Other Areas. The future land-use alternatives considered in detail in the Hanford Remedial Action Draft EIS and for each of the geographic areas are as follows:

- Columbia River—Unrestricted and Restricted
- Reactors on the River—Unrestricted and Restricted
- Central Plateau—Exclusive
- All Other Areas—Restricted

The impacts of remediation in these areas at Hanford are included as reasonably foreseeable impacts in this section.

In addition to these programs being conducted at the Hanford Site, other non-DOE nuclear facilities at or near the Hanford Site contribute to radioactive releases and potentially to cumulative impact. These facilities include the commercial radioactive burial ground at the Hanford Site, the commercial nuclear generating station at the Hanford Site, a nuclear fuel production plant, a commercial low-activity radioactive waste compacting facility, and a commercial decontamination facility.

Table 11.6–2 identifies the range of cumulative impacts resulting from these other actions, the waste management alternatives, and current activities. To calculate the cumulative impacts of the alternatives for the Hanford Site, DOE used the impacts of the preferred alternative contained in the EISs mentioned above.

As identified in Table 11.6–2, the maximum annual radioactive releases to the atmosphere from the combined waste management activities (including transportation) would result in an increase in the dose to the offsite population. The maximum increase in radioactive releases under the combined alternatives primarily results from the Hanford Site being considered as the single candidate site for the treatment and disposal of all contact-handled LLMW and LLW under the Centralized Alternatives. Cumulative radioactive

Table 11.6-2. Hanford Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	6.00E+00	2.70E+00	5.30E+02	2.75E+00	2.74E+02	2.83E+02	8.10E+02	2.83+02
Number of cancer fatalities from collective dose	(2)	~0	~0	2.65E-01	~0	1.37E-01	1.41E-01	4.05E-01	1.41E-01
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	3.70E-03	5.60E-03	1.10E+00	5.71E-03	1.91E+00	1.92E+00	3.01E+00	1.92E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	2.10E+03	3.53E+03	1.59E+04	1.31E+04	1.26E+04	1.82E+04	3.06E+04	2.78E+04
Number of cancer fatalities from collective dose	(1)	8.40E-01	1.41E+00	6.37E+00	5.23E+00	5.03E+00	7.29E+00	1.22E+01	1.11E+01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	1,310	15,000	290,304	275,510	830	17,140	292,444	277,650
Number of rail shipments (10 yr)		0	3,000	106,356	102,920	0	3,000	106,356	102,920
Annual dose (mrem) from truck transport		5.2E-01	6.0E-01	1.68E+00	1.12E+00	3.3E-02	1.16E+00	2.2E+00	1.68E+00
Annual dose (mrem) from rail transport		0.0E+00	1.2E-01	5.65E-01	3.95E-01	0.0E+00	1.2E-01	5.7E-01	3.95E-01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	11%	0.00%	0.09%	0.06%	0.98%	12%	12%	12%
Water use (% of total capacity)		12%	0.02%	0.46%	0.29%	0.94%	13%	13%	13%
Wastewater production (% of treatment capacity)		79%	5.09%	84.59%	39.68%	4.35%	88%	168%	123%
Power demand (% current load)		17%	0.66%	13.34%	12.52%	22.74%	40%	53%	52%
Employment									
Number of site workers	(7)	14,613	609	5,343	3,659	10,260	25,482	30,216	28,532
Air Quality Exceedances	(8)	None	None	NO_2, PM_{10}	None	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240
Groundwater Quality Exceedances	(9)	14 parameters exceeded	None	U-238, 4 hazardous chemicals[e]	U-238, 4 hazardous chemicals[e]	U-238	15 parameters exceeded	18 parameters exceeded	18 parameters exceeded

[a] Other reasonably foreseeable future actions include actions addressed in EISs related to spent nuclear fuel management (including spent nuclear fuel from foreign research reactors) (DOE, 1995d), tank waste remediation system (DOE, 1996d), management of spent nuclear fuel from the K Basin (DOE, 1996a), disposal of decommissioned Naval nuclear plants (Navy, 1996), storage and disposition of weapons-grade fissile materials (DOE, 1996c), plutonium finishing plant stabilization (DOE, 1996e), and remedial actions (DOE 1996j).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed drinking water standards in groundwater include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based in DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

releases, including the maximum releases associated with the combined WM PEIS alternatives and contributions estimated at 0.05 millirems per year from commercial nuclear facilities at or near the Hanford Site, would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

The Hanford Site is in an attainment region where criteria air pollutants do not exceed standards. In the alternatives that result in maximum atmospheric emissions, the standards for NO_2 and particulate (PM_{10}) emissions could be exceeded; mitigation measures would be necessary to reduce these emissions if these alternatives are chosen. The combined preferred alternatives are not expected to result in exceedance of any air quality standards. Remedial action at Hanford could result in temporary exceedances of standards for several additional compounds.

The combined alternatives would affect between 7 and 178 acres of land at the Hanford Site. This area is less than 1% of the total suitable acreage at Hanford and 3% of the area available for waste management facilities. Other actions could affect another 1,949 acres. Although the combined alternatives and other actions would only cumulatively affect a maximum of about 1% of the suitable acreage at the Hanford Site, the land affected may require detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts prior to disturbance.

Although the cumulative demand for water and power would not be greatly affected by the combined alternatives, a maximum cumulative increase of 169% in wastewater generation could require new or upgraded wastewater treatment facilities at the Hanford Site. The combined alternatives could add up to 5,343 jobs at the Hanford Site, while other actions could increase the number of jobs at the Hanford Site by 10,260. Cumulatively, the number of jobs at Hanford could increase by up to 107% over current employment levels, which could impact existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse impacts resulting from this increase in employment.

Disposal of LLMW at the Hanford Site under the Decentralized Alternative; Regionalized Alternatives 1, 2, and 4; and the Centralized Alternative could result in exceedances of drinking water standards in groundwater for benzene, carbon tetrachloride, 1,2-dichloroethane, methylene chloride, and U-238. Disposal of LLW at Hanford could result in concentrations of U-238 that exceed drinking water standards under the Decentralized Alternative; Regionalized Alternatives 1 through 6; and Centralized Alternatives 1, 3, and 5. Disposal under the combined preferred alternatives for LLMW and LLW would result in these same groundwater quality exceedances. To meet drinking water standards, performance-based waste acceptance criteria may be needed for onsite disposal of LLMW and LLW.

11.7 Idaho National Engineering Laboratory

Idaho National Engineering Laboratory (INEL) would continue in the future to conduct programs that include building, testing, and operating various types of nuclear facilities, and focusing on environmental restoration, waste management, and technology development. The existing environmental conditions at INEL resulting from these ongoing activities are described in Chapter 4.

11.7.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, HLW, and HW at INEL. Table 11.7–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for INEL. The most adverse impacts at INEL and in the INEL region would occur as a result of some Regionalized and Centralized Alternatives for which treatment and disposal facilities would be constructed for INEL to manage its own waste, in addition to accepting offsite LLMW and LLW for treatment and disposal and offsite TRUW for treatment. The least adverse impacts at INEL and in the INEL region generally would result from Decentralized and other Regionalized Alternatives for which INEL would primarily be responsible for its own waste or would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at INEL are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

1.7.2 Cumulative Impacts

Aside from continuation of existing operations and the waste management activities presented in this PEIS, several additional actions are planned or being undertaken by DOE at INEL and are included as reasonably foreseeable future actions in this analysis. These actions are considered in several EISs and include continued management of spent nuclear fuel (including spent nuclear fuel from naval reactors and foreign

Table 11.7-1. Idaho National Engineering Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	9.9E-03	R2-4	1.3E+00	C	4.9E-06	R4	6.7E-04	C	4.9E-09	N	1.9E-06
Low-Level[a]	D,R1,3, C5	1.6E-03	R5	8.2E-01	D,R1,3, C5	8.0E-07	R5	4.1E-04	--	--	--	--
Transuranic	N	1.3E-05	R3	8.2E+01	N	6.7E-09	R3	4.1E-02	N	1.7E-12	C	6.6E-09
High-Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	D	--	R2	9.7E-04
Total		**1.2E-02**		**8.4E+01**		**5.7E-06**		**4.2E-02**		**4.9E-09**		**9.7E-04**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	1.2E-06	R4	1.7E-04	C	6.1E-10	R4	8.4E-08	C	6.7E-13	R2	2.6E-07
Low-Level[a]	D,R1,3, C5	2.0E-07	R5	1.0E-04	D,R1,3, C5	9.9E-11	R5	5.1E-08	--	--	--	--
Transuranic	N	1.7E-09	R3	1.0E-02	N	8.4E-13	R3	5.1E-06	N	<9.9E-14	C	9.1E-13
High-Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	D	0.0E+00	R2	1.3E-07
Total		**1.4E-06**		**1.0E-02**		**7.1E-10**		**5.2E-06**		**6.7E-13**		**3.9E-07**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R4	1,740 / 760	N	0.0E+00	R4	2.80E-05	N	0.0E+00	R4	1.20E-05
Low-Level	N,D,R1-R4	0 / 0	R5	25,620 / 10,020	N,D,R1-R4	0.0E+00	R5	4.10E-04	N,D,R1-R4	0	R5	1.60E-04
Transuranic	N	0 / 0	R3	7,610 / 3,820	N	0.0E+00	R3	1.10E-03	N	0.0E+00	R3	1.10E-03
High-Level	N	0 / 0	D,R1,R2, C1,C2	1,700 / 340	N	0	D,R1,R2, C1,C2	6.80E-04	N	0	D,R1,R2, C1,C2	1.40E-04
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**36,670 / 14,940**		**0.0E+00**		**2.2E-03**		**0.0E+00**		**1.4E-03**

Table 11.7-1. Idaho National Engineering Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	6.9E-04	N	3.0E-01	C	3.5E-07	N	1.5E-04	C	6.4E-09	N	2.6E-06
Low-Level[a]	D,R1,3, C5	4.8E-04	R5	2.3E-01	D,R1,3, C5	2.4E-07	R5	1.2E-04	--	--	--	--
Transuranic	N	3.4E-06	R3	2.5E+01	N	1.7E-09	R3	1.2E-02	N	2.3E-12	C	8.7E-09
High-Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	D	--	R2	1.3E-03
Total		**1.2E-04**		**2.5E+01**		**5.9E-07**		**1.2E-02**		**6.4E-09**		**1.3E-03**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	C	12.2	D,R1	55.6
Low Level	All/None	All/None	All	None	All	None	N	7.5	R5	26.5
Transuranic	All/None	All/None	--	--	--	--	N	0.0	R2-C	28.2
High Level	All/None	All/None	--	--	--	--	N	0	D-C	2.0
Hazardous	All/None	All/None	--	--	--	--	N	0.0	R2	3.0
Total	**None[d]**	**PM_{10}**		**None**		**None**		**19.7**		**115.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	21,517	D,R1	110,206	C	1,258	R4	13,239	C	0.32	N	10.34
Low Level	N	4,458	R5	63,961	N	4,458	R5	28,247	R6-C2,5	1.26	R5	7.30
Transuranic	N	3,206	R3	77,743	N	3,206	R3	16,872	N	0.53	R2-C	2.78
High Level	N	0	D-C	820	N	0	D-C	820	N	0.00	D-C	0.03
Hazardous	D		R2	1,823	D		R2	1,108	D	--	R2	0.42
Total		**29,181**		**254,553**		**8,922**		**60,286**		**2.11**		**20.87**

Table 11.7–1. Idaho National Engineering Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.62	R4	2.04	C	0.07	R1-2	0.48	C	836	R4	2,377
Low Level	R6,C2,5	0.60	R5	2.99	R6-C2,5	0.26	R5	3.20	R6-C2,5	693	R5	3,484
Transuranic	N	0.17	R3	2.18	N	0.22	R3	0.91	N	246	R3	2,485
High Level	N	0.00	D-C	0.03	N	0.00	D-C	0.07	N	0	D-C	368
Hazardous	D	0.00	R2	0.13	N,D	0.00	R2	0.02	D	4	R2	137
Total		1.39		7.32		0.55		4.68		1,779		8,851

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; PM_{10} = particulate matter measuring less than 10 microns in diameter; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

research reactors; DOE, 1995d); other site projects such as processing and treatment of HLW, environmental restoration, and infrastructure improvements (DOE, 1995d); and storage and disposition of weapons-usable fissile materials (DOE, 1996b). Table 11.7–2 identifies the range of cumulative impacts resulting from these other actions, the WM PEIS alternatives, and existing activities. To calculate the cumulative impacts at INEL, DOE used the impacts of the preferred alternatives contained in the aforementioned EISs. While there are no other nuclear facilities in the vicinity of INEL, two commercial facilities in Pocatello, Idaho, release naturally occurring radionuclides from phosphate processing. Lack of inclusion of the impacts of these facilities would not affect the relative impacts of alternatives, and the current analysis is thought to be sufficient to make programmatic decisions.

The environmental restoration program at INEL will address cleanup of an estimated 849,700 m^3 of contaminated media and facilities (200,000 m^3, 640,000 m^3, and 9,700 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). The cumulative impacts analysis includes a number of environmental remediation and decontamination projects that have been evaluated in DOE (1995d), including remediation of groundwater, Pit 9 retrieval, and decontamination and decommissioning of facilities at the Chemical Processing Plant and reactor areas. Environmental analyses of future environmental restoration activities conducted at INEL under the authority of CERCLA will be incorporated into CERCLA documentation and will include NEPA values. These reports will be available for public review and comment through the CERCLA process.

As identified in Table 11.7–2, the cumulative radioactive releases from the combined alternatives and other actions would result in an increase in the radiation dose to the offsite population. The maximum cumulative increase in radioactive releases would primarily result from environmental restoration activities at the site. However, maximum cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

INEL is in an attainment region where criteria air pollutants do not exceed standards. The emissions from the combined alternatives would not result in air quality standard exceedances, except for particulates. Maximum combined waste management alternatives are expected to result in exceedance of air quality standards for particulates (PM_{10}). Mitigation measures could be necessary to reduce these emissions if the maximum combined alternatives were chosen. The preferred alternatives are not expected to result in exceedance of the PM_{10} standard. No exceedances of drinking water standards in groundwater are expected for disposal of any waste type.

Table 11.7-2. Idaho National Engineering Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts: Minimum	Combined Waste Management Impacts: Maximum	Combined Waste Management Impacts: Preferred Alternative	Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]: Minimum[c]	Cumulative Impacts[b]: Maximum[d]	Cumulative Impacts[b]: Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	3.00E-01	1.20E-02	8.40E+01	8.33E+01	2.70E+01	2.73E+01	1.11E+02	1.11E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.50E-03	1.40E-04	1.00E+00	1.00E+00	5.80E-01	5.82E-01	1.58E+00	1.58E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	7.50E+02	1.79E+03	5.07E+03	3.94E+03	4.20E+02	2.96E+03	6.24E+03	5.11E+03
Number of cancer fatalities from collective dose	(1)	3.00E-01	7.16E-01	2.03E+00	1.58E+00	1.68E-01	1.18E+00	2.50E+00	2.04E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	580	0	36,670	23,670	15,332	15,912	52,582	39,582
Number of rail shipments (10 yr)		0	0	14,940	9,770	5,932	5,932	20,872	15,702
Annual dose (mrem) from truck transport		2.3E-01	0.0E+00	2.2E-01	2.01E-01	6.1E-01	8.5E-01	1.1E+00	1.05E+00
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.4E-01	1.32E-01	2.4E-01	2.4E-01	3.8-01	3.69E-01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	2%	0.00%	0.02%	0.01%	0.19%	2%	2%	2%
Water use (% of total capacity)		17%	0.09%	0.82%	0.49%	0.90%	18%	19%	18%
Wastewater production (% of treatment capacity)		25%	0.89%	6.03%	3.94%	0.62%	27%	32%	30%
Power demand (% current load)		76%	3.84%	37.95%	14.20%	38.45%	118%	152%	129%
Employment									
Number of site workers	(7)	12,422	513	4,687	1,913	1,452	14,387	18,561	15,787
Air Quality Exceedances	(8)	None	None	PM_{10}	None	PM_{10}	PM_{10}	PM_{10}	PM_{10}
Groundwater Quality Exceedances	(9)	1 parameter exceeded	None	None	None	None	1 parameter exceeded	1 parameter exceeded	1 parameter exceeded

[a] Other reasonably foreseeable future actions include actions addressed in EISs related to storage and disposition of weapons-usable fissile materials (DOE, 1996b), spent nuclear fuel management (including spent nuclear fuel from naval reactors and foreign research reactors), and INEL environmental restoration and waste management (DOE, 1995d).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as approximately zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and non-involved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined alternatives would affect between 20 and 117 acres of land at INEL. This area is less than 1% of the total suitable acreage at INEL and less than 1% of the area available for waste management facilities. Other actions could affect another 1,059 acres. Although existing operations, the combined alternatives, and other actions would only cumulatively affect a maximum of about 2% of the suitable acreage at INEL, any land to be disturbed may require detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts.

Although the demand for water, wastewater, and power would not be greatly affected by the combined alternatives, the capacities for these services at the INEL could require improvements (expansions or upgrades) as a result of the demands of other actions. The combined alternatives could add up to 4,687 jobs at INEL, while other actions could increase the number of jobs at INEL by 1,452. Cumulatively, the number of jobs at INEL could increase by up to 49% over current employment, which could impact existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse impacts.

11.8 Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL) would continue in the future to conduct defense and related programs that include laser research, biomedical and environmental research, and environmental restoration and waste management activities. The existing environmental conditions at LLNL resulting from these ongoing activities are described in Chapter 4.

11.8.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at LLNL. Table 11.8-1 lists the minimum and maximum combined impacts of the waste management alternatives for LLNL. The most adverse impacts at LLNL and in the LLNL region would occur as a result of the Regionalized Alternatives for which treatment and disposal facilities would be constructed for LLNL to manage its own waste and accept LLMW and LLW from offsite facilities for treatment and disposal. The least adverse impacts at LLNL and in the LLNL region generally would result from those alternatives for which LLNL would either manage only its own waste or prepare, package, and ship its waste for offsite treatment and disposal. For most

Table 11.8–1. Lawrence Livermore National Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	8.8E-04	D,R1	3.1E+02	R2-C	4.4E-07	R1	1.6E-01	R2-C	4.5E-07	N	9.1E-05
Low Level[a]	N	7.1E-04	R2	7.7E+02	N	3.5E-07	R2	3.9E-01	--	--	--	--
Transuranic	N	2.2E-03	R1-C	7.3E-03	N	1.1E-06	R1-C	3.6E-06	N	1.4E-08	R1-C	2.2E-07
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		3.8E-03		1.1E+03		1.9E-06		5.5E-01		4.6E-07		9.1E-05

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.4E-08	R1	5.1E-03	R2-C	7.2E-12	R1	2.6E-06	R2-C	1.0E-11	N	2.0E-09
Low Level[a]	N	1.2E-08	R2	1.3E-02	N	6.0E-12	R2	6.3E-06	--	--	--	--
Transuranic	N	3.6E-08	R1-C	1.2E-07	N	1.8E-11	R1-C	5.9E-11	N	3.1E-13	R1-C	4.8E-12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		6.2E-08		1.8E-02		3.1E-11		8.9E-06		1.0E-11		2.0E-09

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R1	310 / 180	N	0.0E+00	R1	5.00E-06	N	0.0E+00	R1	2.9E-06
Low Level	N	320 / 120	D,R1,R4, R5,C4 / D,R1-R2	570 / 230	N	5.20E-06	D,R1,R4, R5,C4	9.20E-06	N	1.9E-06	D,R1-R2	3.7E-06
Transuranic	N	0 / 0	D	260 / 130	N	0.0E+00	D	3.9E-05	N	0.0E+00	D	3.9E-05
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		320 / 120		1,140 / 540		5.2E-06		5.3E-05		1.9E-06		4.6E-05

Table 11.8–1. Lawrence Livermore National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	4.1E–05	R1	4.3E+00	R2-C	2.0E–08	R1	2.2E–03	R2-C	1.1E–07	N	2.2E–05
Low Level[a]	N	3.2E–05	R2	1.1E+01	N	1.6E–08	R2	5.3E–03	--	--	--	--
Transuranic	N	1.1E–04	R1-C	3.6E–04	N	5.3E–08	R1-C	1.8E–07	N	3.4E–09	R1-C	5.2E–08
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.8E–04**		**1.5E+01**		**8.9E–08**		**7.5E–03**		**1.1E–07**		**2.2E–05**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R2-C	1.1	N	21.7
Low Level	All/None	All/None	All	None	All	None	N	1.0	R2	10.0
Transuranic	All/None	All/None	--	--	--	--	N	0.0	D-C	1.6
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**		**None**		**2.1**		**33.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1,277	N	70,507	R2-C	652	R1	7,769	R2-C	0.71	N	10.10
Low Level	N	1,224	R2	19,972	N	683	R2	4,025	N	0.12	R2	1.05
Transuranic	N	898	D-C	2,455	R1-C	809	D	1,345	N	0.1	D-C	0.21
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3,399**		**92,934**		**2,144**		**13,139**		**0.93**		**11.36**

Table 11.8-1. Lawrence Livermore National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	0.01	R1	0.08	R2-C	0.00	R1	0.02	R2-C	77	R1	846
Low Level	N	0.01	R2	0.04	N	0.00	R2	0.02	R3-C5	214	R2	593
Transuranic	N,R3-C5	0.09	R2-C	0.36	N,R1	0.00	D, R2-C	0.01	N	87	R2-C	291
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.11**		**0.48**		**0.00**		**0.05**		**378**		**1,730**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. Lawrence Livermore National Laboratory does not have high-level waste, and no new hazardous waste facilities are considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

impact categories, the combined impacts of the preferred alternatives at LLNL are well below the impacts of the maximum combined waste management alternatives at the site.

11.8.2 Cumulative Impacts

Aside from continuation of existing operations, the waste management activities addressed in this PEIS, and environmental restoration activities, reasonably foreseeable future actions at LLNL include projects that have been evaluated in a previous sitewide EIS (DOE, 1992b) and in the stockpile stewardship and management EIS (DOE, 1996f). Table 11.8–2 identifies the range of cumulative impacts that could result from the combined waste management alternatives, additional planned actions, and current activities. In addition to these DOE actions, closures and realignment of military bases in the LLNL region could contribute to the cumulative impacts of waste management alternatives.

The environmental restoration program at LLNL will address soil and groundwater contamination; and while some cleanup actions will generate hazardous wastes, no LLW, LLMW, or TRUW is projected to be generated as a result of cleanup actions. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities at LLNL have had no significant adverse environmental impacts based on the reviews completed to data under CERCLA, RCRA, and NEPA. Project-specific environmental evaluations that incorporate cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

As identified in Table 11.8–2, the annual radioactive releases that would result from the combined alternatives would result in an increase the current radiation dose to the offsite population. However, the maximum cumulative radioactive release would not exceed the EPA standard of 10 millirems per year to the maximally exposed individual offsite. LLNL is in an attainment region for all criteria air pollutants. Emissions from the combined alternatives would not exceed air quality standards, although other actions are expected to result in exceedance of the nitrogen dioxide standard. Disposal of LLMW or LLW at LLNL is not expected to result in exceedance of drinking water standards in groundwater under any of the alternatives. No disposal of LLMW or LLW would occur at LLNL under the preferred alternatives.

Table 11.8–2. Lawrence Livermore National Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.70E+01	3.80E-03	1.10E+03	3.30E+02	5.20E+00	2.22E+01	1.12E+03	3.52E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	5.50E-01	1.65E-01	~0	~0	5.61E-01	1.76E-01
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	6.90E-01	6.20E-06	1.80E+00	5.33E-01	1.45E-01	8.35E-01	2.64E+00	1.37E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	2.85E+02	4.42E+00	6.09E+02	2.77E+01	8.75E+01	3.77E+02	9.82E+02	4.00E+02
Number of cancer fatalities from collective dose	(1)	1.14E-01	~0	2.44E-01	~0	~0	1.51E-01	3.93E-01	1.60E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	140	320	1,140	1,090	2,755	3,215	4,035	3,985
Number of rail shipments (10 yr)		0	120	540	470	0	120	540	470
Annual dose (mrem) from truck transport		5.6E-02	5.2E-04	5.3E-03	5.24E-03	1.1E-01	1.7E-01	1.7E-01	1.7E-01
Annual dose (mrem) from rail transport		0.0E+00	1.9E-04	4.5E-03	4.44E-03	0.0E+00	1.9E-04	4.6E-03	4.4E-03
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	4%	0.03%	0.41%	0.22%	0.45%	4%	5%	5%
Water use (% of total capacity)		28%	0.13%	3.69%	0.96%	9.14%	38%	41%	39%
Wastewater production (% of treatment capacity)		24%	0.13%	0.78%	0.58%	3.02%	27%	28%	27%
Power demand (% current load)		61%	0.93%	11.36%	1.82%	26.00%	88%	98%	89%
Employment									
Number of site workers	(7)	8,964	141	530	387	2,495	11,600	11,989	11,709
Air Quality Exceedance	(8)	None	None	None	None	NO_2	NO_2	NO_2	NO_2
Groundwater Quality Exceedance	(9)	4 parameters exceeded	None	None	None	None	4 parameters exceeded	4 parameters exceeded	4 parameters exceeded

[a] Other reasonably foreseeable future actions include actions described in Continued Operations EIS (DOE, 1992b) and Stockpile Stewardship and Management EIS (DOE, 1996f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development and that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined alternatives would affect a maximum of about 33 acres of land, or a maximum of less than 1% of the suitable acreage at LLNL. This area is less than 1% of the area available for waste management facilities; other actions would affect an additional 37 acres (0.5%). Onsite infrastructure demands for water, wastewater treatment, and power would increase by a maximum of approximately 11% as a result of the combined alternatives but by as much as 26% as a result of future actions at the site. These infrastructure demands are all within the existing capacities of the site, and no upgrades should be required.

The combined alternatives could add up to 530 jobs at LLNL, while other actions could increase the number of jobs by 2,495. Cumulatively, the number of jobs could increase by up to 38% over existing employment, potentially offsetting approximately 2,220 jobs that will be lost within the region as a result of closures and the realignments of military bases (DBCRC, 1995). The maximum cumulative increase in employment is not expected to affect offsite community infrastructures or institutions.

11.9 Los Alamos National Laboratory

Los Alamos National Laboratory (LANL) would continue in the future to conduct programs in nuclear weapons research and development and related projects. The existing environmental conditions at LANL resulting from these ongoing activities are described in Chapter 4.

11.9.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, and HW at LANL. Table 11.9–1 lists the minimum and maximum combined impacts of the waste management alternatives for LANL. The most adverse impacts at LANL and in the LANL region would occur as a result of the Regionalized and Centralized Alternatives for which treatment and disposal facilities would be constructed for LANL to manage its own waste in addition to accepting offsite LLMW, LLW, and TRUW for treatment and LLMW and LLW for disposal. The least adverse impacts generally would result from the No Action Decentralized, and Centralized Alternatives for which LANL would either only manage its own waste or would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at LANL are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

Table 11.9–1. Los Alamos National Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	7.6E–02	R2,3	1.7E+00	R4,C	3.8E–05	R2,3	8.6E–04	C	1.6E–08	R2	6.9E–06
Low Level[a]	N	3.9E–01	R2,4,C3, 4	1.6E+01	N	1.9E–04	R2,4,C3, 4	7.8E–03	--	--	--	--
Transuranic	N	8.3E–03	R2	1.3E+03	N	4.1E–06	R2	6.4E–01	N	2.3E–11	R3,C	1.9E–09
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	R1	1.9E–02
Total		**4.7E–01**		**1.3E+03**		**2.3E–04**		**6.5E–01**		**1.6E–08**		**1.9E–02**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	8.0E–06	R2,3	1.8E–04	R4,C	4.0E–09	R2,3	9.1E–08	C	2.0E–12	R2	8.5E–10
Low Level[a]	N	4.1E–05	R2,4,C3, 4	1.6E–03	N	2.0E–08	R2,4,C3, 4	8.2E–07	--	--	--	--
Transuranic	N	8.7E–07	R2	1.3E–01	N	4.4E–10	R2	6.7E–05	D	8.3E–14	R3,C	2.3E–13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	R1	2.4E–06
Total		**5.0E–05**		**1.3E–01**		**2.4E–08**		**6.8E–05**		**2.0E–12**		**2.4E–06**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D	0 / 0	R2	2,610 / 1,020	N,D	0.0E+00	R2	4.20E–05	N,D	0.0E+00	R2	1.6E–05
Low Level	N,D	0 / 0	C3,C4	36,640 / 14,400	N,D	0.0E+00	C3,C4	5.90E–04	N,D	0.0E+00	C3,C4	2.3E–04
Transuranic	N	0 / 0	D	1,590 / 800	N	0.0E+00	D	2.4E–04	N	0.0E+00	D	2.4E–04
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**40,840 / 16,220**		**0.0E+00**		**8.7E–04**		**0.0E+00**		**4.9E–04**

Table 11.9–1. Los Alamos National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	1.5E–03	R2,3	3.5E–02	R4,C	7.5E–07	R2,3	1.7E–05	C	8.1E–09	R2	3.4E–06
Low Level[a]	N	2.6E–02	R2,4,C3, 4	1.4E+00	N	1.3E–05	R2,4,C3, 4	7.0E–04	--	--	--	--
Transuranic	N	7.6E–04	R2	1.2E+02	N	3.8E–07	R2	5.8E–02	N	1.1E–11	R3,C	9.4E–10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	0.0E+00	R1	9.5E–03
Total		**2.8E–02**		**1.2E+02**		**1.4E–05**		**5.9E–02**		**8.1E–09**		**9.5E–03**

Waste Type	Air Quality Exceedances		Groundwater Quality Exceedances				Resource Requirements			
	Construction	Operation					Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R2, 4	None	D, R1	Methylene chloride	R4,C	4.8	N	20.8
Low Level	All/None	All/None	All	None	All	None	R6-C2,5	3.3	R4	18.5
Transuranic	All/None	R2/Radiation	--	--	--	--	N	0	D	15.4
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous	All/None	R1/Vinyl Chloride	--	--	--	--	N,R2	--	D, R1	1.0
Total	**None[d]**	**Radiation and Vinyl Chloride**		**None**		**Methylene chloride**		**8.1**		**55.7**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	2,149	N	69,589	R4,C	597	R2	5,078	R4,C	0.61	N	10.00
Low Level	R6-C2,5	5,714	R4	35,601	R6-C2,5	1,739	R4	15,828	R5-C2	1.49	R4	3.89
Transuranic	N	1,850	R1	34,966	N	1,850	R2	6,974	N	0.25	R3,C	1.94
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N,R2	--	R1	1,777	N,R2	--	R1	907	N,R2	--	R1	0.26
Total		**9,713**		**141,933**		**4,186**		**28,787**		**2.35**		**16.09**

Table 11.9–1. Los Alamos National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,R4,C	0.01	R2	0.05	C	0.05	R2	0.48	C	109	R2	869
Low Level	R6-C2,5	0.30	R4	2.36	R6-C2,5	0.14	R4	1.42	R6-C2,5	287	R4	2,270
Transuranic	N	0.09	R2	1.07	N	0.14	R2	0.49	N	110	R2	1,030
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N,R2	--	R1	0.07	N,R2	--	R1	0.03	N, R2	--	R1	66
Total		**0.40**		**3.55**		**0.33**		**2.42**		**506**		**4,235**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. The Los Alamos National Laboratory does not have high-level waste. Hazardous waste does not contain radioactive materials and, therefore, does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

11.9.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at LANL include construction and operation of the dual-axis hydrodynamic test facility (DOE, 1995e), medical isotope production project (DOE, 1996c), stockpile stewardship and management (DOE, 1996f), the transfer of non-nuclear functions (DOE, 1993), and environmental restoration activities. No other DOE or non-DOE actions are planned in the LANL region that would contribute to the cumulative impacts of waste management alternatives.

The environmental restoration program at LANL will address cleanup of an estimated 9,804,400 m^3 of contaminated media and facilities (500,000 m^3, 9,300,000 m^3, and 4,400 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities have had no significant adverse environmental impacts based on the NEPA reviews completed to date. Project-specific environmental evaluations that incorporate cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

Table 11.9–2 identifies the range of cumulative impacts at LANL resulting from the combined waste management alternatives, existing waste management activities, and planned actions described in the aforementioned EISs. The impacts of other projects being considered for LANL as part of a planned sitewide EIS currently in preparation (DOE, 1994a) are not yet available.

As identified in Table 11.9–2, the annual radioactive releases that would result from the combined waste management alternatives (including transportation) would result in an increase in the radiation dose to the offsite population. Without mitigation, the cumulative radioactive releases for the maximum combined waste management alternatives would exceed the EPA standard of 10 millirems per year to the maximally exposed individual offsite, almost entirely as a result of the treatment of TRUW. This exceedance would require mitigation should the maximum combined alternatives be chosen. The combined impacts of the preferred alternatives would not result in the exceedance of this standard.

LANL is in an attainment region where criteria air pollutants do not exceed standards. While minimum cumulative emissions and the cumulative emissions under the preferred alternatives would not exceed air quality standards, maximum cumulative emissions would result in vinyl chloride emissions above regulation

Table 11.9–2. Los Alamos National Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts: Minimum	Combined Waste Management Impacts: Maximum	Combined Waste Management Impacts: Preferred Alternative	Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]: Minimum[c]	Cumulative Impacts[b]: Maximum[d]	Cumulative Impacts[b]: Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.40E+01	4.70E-01	1.30E+03	1.73E+00	5.70E+00	2.02E+01	1.32E+03	2.14E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	6.50E-01	~0	~0	~0	6.60E-01	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	7.90E+00	5.00E-03	1.30E+01	1.75E-02	2.00E-02	7.93E+00	2.09E+01	7.94E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	1.94E+03	3.53E+02	2.93E+03	2.64E+03	6.96E+02	2.99E+03	5.6E+03	5.28E+03
Number of cancer fatalities from collective dose	(1)	7.76E-01	1.41E-01	1.17E+00	1.06E+00	2.78E-01	1.20E+00	2.2E+00	2.11E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	270	0	40,840	22,600	720	990	41,830	23,590
Number of rail shipments (10 yr)		0	0	16,220	8,730	0	0	16,220	8,730
Annual dose (mrem) from truck transport		1.1E-01	0.0E+00	8.7E-02	5.72E-02	2.1E-02	1.3E-01	2.2E-01	1.86E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	4.9E-02	3.66E-02	0.0E+00	0.0E+00	4.9E-02	3.66E-02
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	41%	0.03%	0.20%	0.16%	0.04%	41%	41%	41%
Water use (% of total capacity)		41%	0.10%	1.42%	0.86%	0.31%	41%	43%	42%
Wastewater production (% of treatment capacity)		Not available	0.42%	2.88%	1.88%	0.16%	1%	3%	2%
Power demand (% current load)		57%	1.96%	13.41%	4.68%	11.58%	70%	82%	73%
Employment									
Numbers of site workers	(7)	6,546	243	1,742	1,017	559	7,348	8,847	8,122
Air Quality Exceedance	(8)	None	None	Vinyl chloride, radiation	None	None	None	Vinyl chloride, radiation	None
Groundwater Quality Exceedance	(9)	13 parameters exceeded	None	Methylene chloride	None	None	13 parameters exceeded	14 parameters exceeded	13 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to dual-axis radiographic hydrodynamic test facility (DOE, 1995e), medical isotope production (DOE, 1996c), transfer of non-nuclear functions (DOE, 1993), and stockpile stewardship and management (DOE, 1996f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

limits as a result of the treatment of hazardous waste under HW Regionalized Alternative 2. Mitigation would be needed to reduce vinyl chloride emissions to acceptable levels if this alternative is chosen.

The combined alternatives would affect a maximum of 56 acres of land. This area is less than 1% of the suitable acreage at LANL and less than 1% of the area available for waste management facilities. An additional 10 acres (0.04%) of land would be affected by other actions. Onsite infrastructure demands for water, wastewater treatment, and power would increase little as a result of the combined alternatives, and cumulative demands would be within existing capacities. The combined alternatives could add up to 1,742 jobs at LANL, or a maximum increase of approximately 27% over existing employment, while other actions would add another 559 jobs. The maximum increase in employment could affect offsite community infrastructures or institutions. Mitigation measures could be needed to reduce any adverse impacts resulting from these increases in employment.

Disposal of LLMW at LANL under the Decentralized Alternative and Regionalized Alternative 1 could result in exceedances of standards for groundwater used as drinking water for methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should either of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at LANL, nor are there any expected exceedances for other waste types. Disposal of LLMW and LLW under the preferred alternatives is not expected to result in any groundwater quality exceedances.

11.10 Nevada Test Site

Nevada Test Site (NTS) has been the nation's primary location for testing nuclear explosive devices, although current U.S. policy prohibits underground testing of nuclear weapons. NTS is a LLW disposal site. The existing environmental conditions at NTS resulting from these ongoing activities are described in Chapter 4.

11.10.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at NTS. Table 11.10-1 lists the minimum and maximum combined impacts of the waste management alternatives considered for NTS. The most

Table 11.10-1. Nevada Test Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.3E-05	N	1.2E-02	R1-C	6.4E-09	N	5.8E-06	R1-C	1.5E-11	N	4.7E-08
Low Level[a]	N	2.6E-09	R2,4,5, 6,C1,3, 4,5	3.2E-09	N	1.3E-12	R2,4,5, 6,C1,3, 4,5	1.6E-12	--	--	--	--
Transuranic	N	0.0E+00	R1-C	3.0E-07	--	0.0E+00	R1-C	1.5E-10	N	0.0E+00	R1-C	1.1E-12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.3E-05**		**1.2E-02**		**6.4E-09**		**5.8E-06**		**1.5E-11**		**4.7E-08**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	3.2E-09	N	3.0E-06	R1-C	1.6E-12	N	1.5E-09	R1-C	<9.9E-14	N	1.2E-11
Low Level[a]	N	6.7E-13	R2,4,5, 6,C1,3, 4,5	8.1E-13	All	<9.9E-14	All	<9.9E-14	--	--	--	--
Transuranic	N	0.0E+00	R1-C	7.8E-11	N	0.0E+00	R1-C	3.9E-14	All	<9.9E-14	All	<9.9E-14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.2E-09**		**3.0E-06**		**1.6E-12**		**1.5E-09**		**0.0E+00**		**1.2E-11**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R3	9,640 / 3,690	N	0.0E+00	R3	1.50E-04	N	0.0E+00	R3	5.9E-05
Low Level	D,R1,R2, C3	0 / 0	C2	257,270 / 96,880	D,R1, R2,C3	0	C2	4.10E-03	D,R1,R2, C3	0.0E+00	C2	1.6E-03
Transuranic	N	0 / 0	D	90 / 90	N	0.0E+00	D	1.40E-05	N	--	D	1.5E-05
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**267,000 / 100,620**		**0.0E+00**		**4.3E-03**		**0.0E+00**		**1.7E-03**

Table 11.10–1. Nevada Test Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.7E-05	N	3.1E-02	R1-C	8.7E-09	N	1.5E-05	R1-C	2.1E-10	N	6.2E-07
Low Level[a]	N	6.0E-09	R2,4,5, 6,C1,3, 4,5	7.2E-09	N	3.0E-12	R2,4,5, 6,C1,3, 4,5	3.6E-12	--	--	--	--
Transuranic	N	0.0E+00	R1-C	8.4E-07	[illegible]	0.0E+00	R1-C	4.2E-10	N	0.0E+00	R1-C	1.5E-11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		1.7E-05		3.1E-02		8.7E-09		1.5E-05		2.1E-10		6.2E-07

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R2, R4	None	R3	3 hazardous chemicals[c]	R2,4,C	5.7	D	25.2
Low Level	C2,4/CO	C2,5/CO	All	None	--		R6,C1,3,5	0.5	C4	15.2
Transuranic	All/None	All/None	All	None	--		N,R1-C	0.0	D	1.2
High Level[a]	--	--	--	--	--		--	--	--	--
Hazardous[a]	--	--	--	--	--		--	--	--	--
Total	CO[d]	CO		None		3 hazardous chemicals[c]		6.2		40.4

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2,4,C	6,593	D	52,725	R2,4,C	936	D	9,352	R1,2,4,C	0.46	D	6.52
Low Level	R6,C1,3,5	553	C2	54,787	R6,C1,5	251	C2	22,196	R6,C1,3,5	0.5	C4	15.2
Transuranic	R1-C	38	D	1,465	R1-C	38	D	609	N,R1-C	0.02	D	0.12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		7,184		107,512		1,225		32,157		0.98		21.84

Table 11.10-1. Nevada Test Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.02	R3	0.13	N	0.01	R3	0.07	N	120	R3	702
Low Level	R2,6,C1, 3,5	0.01	C2	0.57	R2,6, C1,3,5	<0.01	C2	0.25	R6,C1,3,5	55	C2	2,986
Transuranic	R1-C	0.00	D	0.02	R1-C	0.00	N,D	0.01	R1-C	7	D	96
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.03**		**0.72**		**0.01**		**0.33**		**182**		**3,784**

Notes: Alt. = alternative; C = Centralized Alternative; CO = carbon monoxide; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. The Nevada Test Site does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Hazardous chemicals include 1,2-dichloroethane, methylene chloride, and benzene. The NTS EIS (DOE 1996g) did not indicate groundwater quality exceedances. Waste management values overestimate groundwater exceedances for NTS since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

adverse impacts at NTS and in the NTS region generally would occur as a result of the No Action and Regionalized 3 Alternatives for LLMW, Regionalized and Centralized Alternatives for LLW, and Regionalized and Centralized Alternatives for TRUW. The least adverse impacts at NTS and in the NTS region generally would result from the Centralized Alternative for LLMW; the No Action Alternative for LLW; and the No Action Alternative for TRUW. For most impact categories, the combined impacts of the preferred alternatives at NTS are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

11.10.2 Cumulative Impacts

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at NTS include stockpile stewardship and management (DOE, 1996f); storage and disposition of weapons-usable fissile materials (DOE, 1996b); and environmental restoration activities and a number of other actions evaluated in a draft sitewide EIS (DOE, 1996g). In addition, the Yucca Mountain Site (located on a portion of NTS) is the candidate site for the nation's geological repository for spent nuclear fuel and HLW under the Nuclear Waste Policy Act (42 USC 10101–10270). No other DOE or non-DOE actions are planned in the NTS region that would contribute to the cumulative impact of waste management alternatives.

Table 11.10–2 identifies the range of cumulative impacts at NTS resulting from the combined waste management alternatives (including transportation), current activities, and planned actions described in the aforementioned EISs. The impacts of a geologic repository for spent nuclear fuel and HLW are not included in this cumulative impact analysis because that information is not yet available.

As identified in Table 11.10–2, the maximum radioactive releases from the combined waste management alternatives would not measurably increase the existing radiological releases from NTS to the offsite population. Maximum cumulative radioactive releases would be below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

The NTS is adjacent to a nonattainment region in Clark County for breathable particulates and carbon monoxide. Maximum cumulative emissions are predicted to exceed applicable air emissions standards for carbon monoxide as a result of the maximum combined alternatives and preferred alternatives, and, as a

Table 11.10–2. Nevada Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	2.90E-01	1.30E-05	1.20E-02	3.60E-05	4.30E-05	2.90E-01	3.02E-01	2.90E-01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.20E-02	3.20E-07	3.00E-04	3.26E-07	9.10E-06	1.20E-02	1.23E-02	1.20E-02
Worker Population									
Collective dose, 10 years (person-rem)	(4)	2.00E+01	7.94E+00	6.49E+03	6.49E+03	6.60E+02	6.88E+02	7.17E+03	7.17E+03
Number of cancer fatalities from collective dose	(1)	~0	~0	2.60E+00	2.60E+00	2.64E-01	2.75E-01	2.87E+00	2.87E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	4,540	0	267,000	267,000	35,134	39,674	306,674	306,674
Number of rail shipments (10 yr)		0	0	100,620	100,620	0	0	100,620	100,620
Annual dose (mrem) from truck transport		1.8E+00	0.0E+00	4.3E-01	4.26E-01	1.4E+00	3.2E+00	3.6E+00	3.65E+00
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.7E-01	1.67E-01	0.0E+00	0.0E+00	1.7E-01	1.67E-01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	26%	0.00%	0.00%	0.00%	2%	28%	28%	28%
Water use (% of total capacity)		49%	0.26%	3.87%	3.18%	300%	349%	353%	352%
Wastewater production (% of treatment capacity)		41%	0.36%	9.51%	9.32%	59%	101%	110%	110%
Power demand (% current load)		67%	2.18%	48.53%	17.76%	44%	113%	160%	129%
Employment									
Number of site workers	(7)	7,086	53	1,544	1,535	8,561	15,700	17,191	17,182
Air Quality Exceedance	(8)	PM_{10}, CO	None	CO	CO	None	PM_{10}, CO	PM_{10}, CO	PM_{10}, CO
Groundwater Quality Exceedance	(9)	8 parameters exceeded	None	3 hazardous chemicals[e]	3 hazardous chemicals[e]	None	8 parameters exceeded	11 parameters exceeded[e]	11 parameters exceeded[e]

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to stockpile stewardship and management (DOE, 1996d), storage and disposition of weapons-usable fissile materials (DOE, 1996b), and the NTS sitewide EIS, which incorporates the impacts of environmental restoration activities (DOE 1996g). Shipment numbers and shipment MEI values do not include those related to stockpile stewardship and management because these were not presented in that EIS.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals include 1,2-dichloroethane, methylene chloride, and benzene. The NTS EIS did not indicate groundwater quality exceedances. Waste management values overestimate groundwater exceedances for NTS since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

consequence, mitigation measures may be necessary to reduce these emissions. Note that the NTS sitewide EIS (DOE, 1996g) predicted no exceedances of air quality standards.

The NTS EIS found that maximum cumulative emissions in the Clark County nonattainment region (primarily from the Las Vegas Valley) exceed standards for carbon monoxide; however, this is not a direct result of NTS activities. Under the NTS EIS combined alternatives, the incremental contribution of carbon monoxide from NTS-related activities would not present a significant addition to the nonattainment status of the adjacent region. In addition, the NTS EIS found that breathable particulates and total suspended particulates, which also exceed standards in the region, are not and would not be directly attributed to NTS activities under the combined alternatives. Therefore, mitigation measures may not be necessary to reduce these emissions due to the insignificance of the contribution from NTS-related activities to the existing pollutant burden.

The combined alternatives would affect up to 40 acres of land at NTS. This area is less than 1% of the total suitable acreage and less than 1% of the area available for waste management facilities. Other actions could affect another 14,481 acres. Although the combined alternatives and other actions would cumulatively affect a maximum of about 2% of the suitable acreage at NTS, the land affected may have to be subjected to detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts.

The cumulative demand for water, wastewater treatment capacity, and power is expected to increase substantially at NTS. Infrastructure improvements (expansion or upgrades) will likely be required to meet these increased demands, and wastewater capacity could require expansion as a result of demands of other planned actions at NTS.

The combined alternatives could add up to of 1,544 jobs at NTS, while other actions could also increase the number of jobs by 8,561. Cumulatively, the number of jobs at the NTS could more than double, which could affect existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse offsite infrastructure and institutional impacts.

Disposal of LLMW at NTS under Regionalized Alternative 3 and under the preferred alternative could result in exceedances of drinking water standards in groundwater for benzene, 1,2-dichloroethane, and methylene chloride. The Decentralized Alternative and Regionalized Alternative 1 are not expected to result in an exceedance for benzene but could result in exceedances for 1,2-dichloroethane and methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at NTS, nor are there any expected exceedances for disposal of LLW. Note that the NTS EIS (DOE, 1996g) predicted no exceedances of drinking water standards in the groundwater from disposal of LLMW or LLW at NTS, and the waste management values are thought to overestimate groundwater exceedances for NTS. Travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

11.11 Oak Ridge Reservation

Oak Ridge Reservation (ORR) would continue in the future to conduct environmental restoration activities and programs that include applied research and development in support of conservation and energy technologies, environmental management activities, and defense programs. The existing environmental conditions at ORR resulting from these ongoing activities are described in Chapter 4.

11.11.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, and HW at ORR. Table 11.11–1 lists the minimum and maximum combined impacts of the waste management alternatives considered. The most adverse impacts at ORR and in the ORR region would occur as a result of the No Action Alternative for LLMW and Regionalized Alternatives for which treatment and disposal facilities would be constructed for ORR to manage its own waste, in addition to accepting offsite LLMW and LLW for treatment and disposal, and offsite TRUW and HW for treatment. The least adverse impacts at ORR and in the ORR region generally would result from those alternatives for which ORR would only be responsible for its own waste or would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at ORR are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

Table 11.11-1. Oak Ridge Reservation Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	1.4E-02	N	2.3E+02	C	6.8E-06	N	1.1E-01	C	1.1E-06	N	4.1E-05
Low Level[a]	N	9.2E-03	R5	6.0E+02	N	4.6E-06	R5	3.0E-01	--	--	--	--
Transuranic	N	1.3E-04	R2-C	9.2E+01	N	6.6E-08	R2-C	4.6E-02	N	7.8E-09	D,R1	1.6E-07
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N	7.4E-03	R2	9.5E-02
Total		2.3E-02		9.2E+02		1.1E-05		4.6E-01		7.4E-03		9.5E-02

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	4.2E-07	N	7.0E-03	C	2.1E-10	N	3.5E-06	C	5.8E-11	N	2.1E-09
Low Level[a]	N	2.9E-07	R5	1.9E-02	N	1.4E-10	R5	9.3E-06	--	--	--	--
Transuranic	N	4.1E-09	R2-C	2.8E-03	N	2.1E-12	R2-C	1.4E-06	N	4.0E-13	D,R1	8.1E-12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N	3.9E-07	R2	5.0E-06
Total		7.1E-07		2.9E-02		3.5E-10		1.4E-07		3.9E-07		5.0E-06

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D,R1	0 / 0	R3	2,100 / 790	N,D,R1	0	R3	3.40E-05	N,D,R1	0	R3	1.3E-05
Low Level	N / N, D,R1,R2	20 / 20	R3	64,590 / 24,470	N	3.20E-07	R3	1.00E-03	N,D,R1, R2	3.2E-07	R3	3.9E-05
Transuranic	N	0 / 0	R1	2,440 / 1,230	N	0.0E+00	R1	3.60E-04	N	0.0E+00	R1	3.7E-04
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	--	--	--	--	--	--	--	--	--	--	--	--
Total		20 / 20		69,130 / 26,490		3.2E-07		1.4E-03		3.2E-07		7.7E-04

Table 11.11–1. Oak Ridge Reservation Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	4.5E–04	N	9.6E+00	C	2.3E–07	N	4.8E–03	C	3.7E–07	N	1.4E–05
Low Level[a]	N	3.1E–04	R5	8.7E+00	N	1.5E–07	R5	4.3E–03	--	--	--	--
Transuranic	N	4.6E–06	R2-C	3.1E+00	N	2.3E–09	R2-C	1.6E–03	N	2.6E–09	D,R1	5.2E–08
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N	2.5E–03	R2	3.2E–02
Total		7.6E–04		2.1E+01		3.8E–07		1.1E–02		2.5E–03		3.2E–02

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R3, C	4 radionuclides	D,R1-C	2 hazardous chemicals, 4 radionuclides[c]	C	5.3	R4	19.1
Low Level	All/None	All/None	All	None	All	None	R6-C2,5	11.6	R3	137.6
Transuranic	All/None	All/None	--	--	--	--	N	0.0	D	6.6
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous	All/None	R1,2/Vinyl Chloride	--	--	--	--	N	0.0	R2	2.0
Total	None[d]	NO_2, PM_{10}, Vinyl Chloride		4 radio-nuclides		2 hazardous chemicals, 4 radio-nuclides[c]		22.8		165.3

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	7,888	R4	32,846	C	4,686	R4	20,085	C	0.74	R4	6.65
Low Level	N	13,701	R3	539,756	R6-C2,5	7,328	R5	47,608	R6-C2,5	2.86	R3	80.69
Transuranic	N	1,425	R2-C	14,448	N	1,425	D	3,929	N	0.14	D	0.69
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N	168	R2	2,438	N	168	R2	2,101	N	0.13	R2	0.58
Total		23,014		589,488		13,439		73,723		3.9		88.61

Table 11.11-1. Oak Ridge Reservation Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts—Continued								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.25	R4	0.76	C	0.15	R4	0.38	N	934	R4	2,233
Low Level	R6-C2,5	0.34	R5	1.82	R6-C2,5	0.16	R5	0.96	R6-C2,5	1,001	R5	5,331
Transuranic	N	0.07	R2-C	0.23	N	0.05	R1-C	0.09	N	243	R2-C	677
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N	0.01	R2	0.04	N,D	0.00	R1, R2	0.01	N	18	R2	135
Total		0.67		2.85		0.36		1.44		2,196		8,376

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; NO_2 = nitrogen dioxide; PM_{10} = particulate matter measuring less than 10 microns in diameter; R = Regionalized Alternative; -- = not applicable; scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. High-level waste is not present at the Oak Ridge Reservation. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

[e] Hazardous chemicals that could exceed drinking water standards include 1,2-dichloroethane and methylene chloride; radionuclides that could exceed standards include Pu-239, Pu-240, Tc-99, and U-238.

11.11.2 Cumulative Impacts

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at ORR include stockpile stewardship and management activities (DOE, 1996f), storage and disposition of weapons-usable fissile materials (DOE, 1996b), the disposition of highly enriched uranium (DOE, 1995f), interim storage of enriched uranium (DOE, 1994i), the transfer of non-nuclear functions (DOE, 1993), and environmental restoration activities. No other DOE or non-DOE actions are planned in the ORR region that would contribute to the cumulative impact of waste management activities.

The environmental restoration program at ORR will address cleanup of an estimated 1,402,400 m^3 of contaminated media and facilities (460,000 m^3, 940,800 m^3, and 1,600 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Future cleanup actions include remediation of contaminated groundwater and soil and decontamination and decommissioning of facilities. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities have had no significant adverse environmental impacts based on the CERCLA and NEPA reviews completed to date. Project-specific environmental evaluations under CERCLA will be performed prior to implementation of all future environmental restoration activities.

Table 11.11–2 identifies the range of cumulative impacts resulting from the waste management alternatives (including transportation), existing activities, and planned actions described in the aforementioned EISs.

As identified in Table 11.11–2, the maximum annual radioactive releases would increase as a result of maximum radiological releases from the combined alternatives and radioactive releases from other possible actions. Maximum cumulative radioactive releases, however, would not exceed the EPA standard of 10 millirems per year to the maximally exposed individual.

ORR is in an attainment region where criteria air pollutants do not exceed standards. The maximum emissions from the combined waste management alternatives could exceed air quality standards for nitrogen dioxide, breathable particulates, and vinyl chloride. Mitigation measures would be necessary to reduce these emissions to acceptable levels should these alternatives be chosen. No exceedances of air quality standards are anticipated for the preferred alternatives at ORR.

Table 11.11-2. Oak Ridge Reservation Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	4.30E+02	2.50E-02	9.20E+02	2.41E+00	1.90E+01	4.49E+02	1.37E+03	4.51E+02
Number of cancer fatalities from collective dose	(2)	2.15E-01	~0	4.60E-01	~0	~0	2.25E-01	6.85E-01	2.26E-01
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.40E+00	7.00E-05	2.90E+00	7.34E-03	5.00E-01	1.90E+00	4.80E+00	1.91E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	6.80E+02	2.40E+02	3.37E+03	2.09E+03	1.11E+03	2.03E+03	5.16E+03	3.88E+03
Number of cancer fatalities from collective dose	(1)	3.40E-01	~0	1.35E+00	8.35E-01	4.44E-01	8.12E-01	2.06E+00	1.55E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	10,400	20	69,130	69,180	1,704	12,124	81,234	81,284
Number of rail shipments (10 yr)		80	20	26,490	26,510	0	100	26,570	26,590
Annual dose (mrem) from truck transport		4.2E+00	3.2E-05	1.30E-01	1.30E-01	6.8E-02	4.2E+00	4.4E+00	4.4E+00
Annual dose (mrem) from rail transport		3.22E-02	3.2E-05	6.83E-02	6.83E-02	0.0E+00	3.2E-02	1.1E-01	1.0E-01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	67%	0.13%	0.97%	0.91%	0.8%	68%	69%	69%
Water use (% of total capacity)		46%	0.06%	1.47%	1.43%	-0.9%	45%	46%	46%
Wastewater production (% of treatment capacity)		70%	1.46%	8.01%	4.25%	13%	84%	91%	87%
Power demand (% current load)		18%	0.59%	13.43%	13.02%	8.8%	27%	40%	39%
Employment									
Number of site workers	(7)	23,597	621	3,453	1,658	754	24,972	26,009	26,009
Air Quality Exceedance	(8)	None	None	NO_2, PM_{10}, vinyl chloride	None	None	None	NO_2, PM_{10}, vinyl chloride	None
Groundwater Quality Exceedance	(9)	17 parameters exceeded	None	2 hazardous chemicals, 4 radionuclides[e]	2 hazardous chemicals, 4 radionuclides[e]	None	17 parameters exceeded	22 parameters exceeded	22 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to stockpile stewardship and management (DOE, 1996f), storage and disposition of weapons-usable fissile materials (DOE, 1996b), transfer of non-nuclear functions (DOE, 1993), interim storage of enriched uranium (DOE, 1994i), and disposition of surplus highly enriched uranium (DOE, 1995f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts
[e] Hazardous chemicals that could exceed drinking water standards include 1,2-dichloroethane and methylene chloride; radionuclides that could exceed standards include Pu-239, Pu-240, Tc-99, and U-238.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment. PM_{10} = particulate matter less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined waste management alternatives would affect between 23 and 165 acres of land at ORR. This area is about 1% of the total suitable acreage and 3% of the area available for waste management facilities. Other actions could affect another 144 acres. Together, the combined alternatives and other actions would affect a maximum of 1.8% of the suitable acreage at ORR and could result in impacts to sensitive land. Detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts may be required prior to any new land disturbance.

The demand for water, wastewater, and power at ORR would not be greatly affected by the combined alternatives. Cumulatively, water, wastewater, and power capacities at ORR would probably not require major improvements (expansions or upgrades) as a result of the construction and operation of planned facilities.

The combined waste management alternatives could add up to 2,453 jobs at ORR, while other actions could also increase the number of jobs at ORR by 754. Cumulatively, the number of jobs at ORR could increase by up to 18%, which could affect existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse offsite infrastructure and institutional impacts.

Disposal of LLMW at ORR under the Decentralized Alternative and Regionalized Alternatives 1, 2 (the preferred alternative), and 4 could result in exceedances of drinking water standards in groundwater for 1,2-dichloroethane, methylene chloride, Pu-239, Pu-240, Tc-99, and U-238. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at ORR, nor are there any expected exceedances for other waste types.

11.12 Paducah Gaseous Diffusion Plant

Paducah Gaseous Diffusion Plant (PGDP) would continue in the future to produce enriched uranium. The existing environmental conditions at PGDP resulting from these ongoing activities are described in Chapter 4.

11.12.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at the PGDP. Table 11.12–1 lists the minimum and maximum combined impacts of the waste management alternatives for PGDP. The most adverse impacts at PGDP and in the PGDP region would occur as a result of the No Action Alternative for LLMW and Regionalized and Centralized Alternatives for LLW and TRUW. The least adverse impacts at PGDP and in the region generally would result from the Regionalized and Centralized Alternatives for LLMW for which PGDP would only prepare, package, and ship waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at PGDP are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.12.2 Cumulative Impacts

Aside from the continuation of existing operations, the waste management activities addressed in this PEIS, and environmental restoration actions, DOE has no other actions planned at PGDP. No other DOE or non-DOE actions are planned in the PGDP region that would contribute to the cumulative impact of the waste management alternatives.

The environmental restoration program at PGDP will address cleanup of an estimated 1,220,000 m^3 of contaminated media and facilities (450,000 m^3, 770,000 m^3, and 7 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Future cleanup actions include remediation of contaminated groundwater and eventual decontamination and decommissioning of uranium enrichment facilities. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities at PGDP have had no significant adverse environmental impacts based on the CERCLA, NEPA, and RCRA reviews completed to date. Project-specific environmental evaluations under CERCLA, RCRA, or NEPA will be performed prior to implementation of all future environmental restoration activities.

Table 11.12–1. Paducah Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.6E–03	N	3.6E+00	R2-C	8.1E–07	N	1.8E–03	R2-C	9.7E–09	N	1.1E–06
Low Level[a]	N	4.0E–05	R2	3.8E–03	N	2.0E–08	R2	1.9E–06	--	--	--	--
Transuranic	N	--	R1-C	1.1E–05	N	--	R1-C	5.3E–09	N	--	R1-C	9.5E–13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.6E–03**		**3.6E+00**		**8.3E–07**		**1.8E–03**		**9.7E–09**		**1.1E–06**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.8E–07	N	4.0E–04	R2-C	9.0E–11	N	2.0E–07	R2-C	1.3E–12	N	1.5E–10
Low Level[a]	N	4.5E–09	R2	4.2E–07	N	2.3E–12	R2	2.1E–10	--	--	--	--
Transuranic	N	--	R1-C	1.2E–09	N	--	R1-C	5.9E–13	All	<9.9E–14	All	<9.9E–14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.8E–07**		**4.0E–04**		**9.3E–11**		**2.0E–07**		**1.3E–12**		**1.5E–10**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R2-R4,C	50 / 30	N	0.0E+00	R2-R4,C	8.1E–07	N	0.0E+00	R2-R4,C	4.8E–07
Low Level	D,R1,R2	10 / 10	N	6,420 / 2,400	D,R1,R2	1.6E–07	N	1.0E–04	D,R1,R2	1.6E–07	N	3.9E–05
Transuranic	N	0 / 0	D-C	10 / 10	N	0.0E+00	D-C	1.5E–06	N	0.0E+00	D-C	3.0E–06
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**10 / 10**		**6,480 / 2,440**		**1.6E–07**		**1.0E–04**		**1.6E–07**		**4.2E–05**

Table 11.12–1. Paducah Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.3E–04	N	2.8E–01	R2-C	6.4E–08	N	1.4E–04	R2-C	5.1E–09	N	5.9E–07
Low Level[a]	N	3.2E–06	R2	3.0E–04	N	1.6E–09	R2	1.5E–07	--	--	--	--
Transuranic	N	--	R1-C	8.2E–07	N	--	R1-C	4.1E–10	N	--	R1-C	5.0E–13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.3E–04**		**1.9E–02**		**6.6E–08**		**9.7E–06**		**5.1E–09**		**3.4E–08**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Min.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R2-C	0.3	D,R1	2.3
Low Level	All/None	All/None	All	None	D,R1,2	Np-237	N	2.9	D,R1	11.2
Transuranic	All/None	All/None	--	--	--	--	N	0	D-C	0.6
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	None[b]	None		None		Np-237		3.8		14.1

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	116	D,R1	2,963	R2-C	176	D,R1	1,541	R2-C	0.25	D,R1	0.45
Low Level	N	2,968	R2	67,852	N	1,682	R2	5,847	N	0.38	D,R1	11.31
Transuranic	N	171	R2-C	880	N	171	D-C	200	N	0.17	R1	0.26
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3,613**		**71,695**		**2,058**		**7,588**		**0.81**		**12.02**

Table 11.12–1. Paducah Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.04	D,R1	0.24	N,R2-C	0.02	D,R1	0.11	N	41	D,R1	221
Low Level	N	0.27	R2	0.88	N	0.14	R2	0.44	R3-C5	276	R2	797
Transuranic	N	0.03	R2-C	0.07	N	0.01	R2-C	0.03	N	32	R2-C	59
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.38**		**1.19**		**0.18**		**0.58**		**349**		**1,077**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. The Paducah Gaseous Diffusion Plant does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.12-2 identifies the range of cumulative impacts that would result from the combined waste management alternatives (including transportation) and current activities at PGDP. As identified in Table 11.12-2, the maximum annual radioactive releases that would result from the waste management alternatives would result in a slight increase in the dose to the offsite population; however, PGDP cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

PGDP is in a nonattainment region for ozone. While the expected atmospheric emissions of ozone-producing contaminants under various alternatives could increase the levels of these emissions, the increases would be below the regulated levels in the nonattainment region. Disposal of LLW at PGDP under the Decentralized and Regionalized Alternatives 1 and 2 could result in exceedance of drinking water standards in groundwater for Np-237. No disposal of LLW would occur at PGDP under the preferred alternative.

The combined alternatives could affect between 4 and 14 acres of land at PGDP. This area is less than 1% of the total suitable acreage and less than 1% of the area available for waste management facilities. Onsite infrastructure demands for water, wastewater treatment, and power would not measurably increase from the combined alternatives. The combined alternatives could add up to 378 jobs at PGDP, or a maximum increase of approximately 20% over existing employment. The maximum increase in employment is not expected to affect offsite community infrastructures or institutions because of the current population and employment base in the PGDP region.

11.13 Pantex Plant

The Pantex Plant would continue in the future to disassemble, assemble, and conduct quality evaluation and maintenance of the nation's nuclear weapons stockpile. The existing environmental conditions at the Pantex Plant resulting from these ongoing activities are described in Chapter 4.

Table 11.12-2. Paducah Gaseous Diffusion Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts: Minimum	Combined Waste Management Impacts: Maximum	Combined Waste Management Impacts: Preferred Alternative	Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]: Minimum[c]	Cumulative Impacts[b]: Maximum[d]	Cumulative Impacts[b]: Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.70E-01	1.60E-03	3.60E+00	1.65E-03	--	1.72E-01	3.77E+00	1.72E-01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	--	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	4.50E-03	1.80E-05	4.00E-02	1.85E-05	--	4.52E-03	4.45E-02	4.52E-03
Worker Population									
Collective dose, 10 years (person-rem)	(4)	5.19E+01	4.07E+00	1.26E+01	4.07E+00	--	5.60E+01	6.45E+01	5.60E+01
Number of cancer fatalities from collective dose	(1)	~0	~0	~0	~0	--	~0	~0	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	9,960	10	6,480	6,330	--	9,970	16,440	16,290
Number of rail shipments (10 yr)		0	10	2,440	2,410	--	10	2,440	2,410
Annual dose (mrem) from truck transport		4.0E+00	1.6E-05	1.0E-02	1.02E-02	--	4.0E+00	4.0E+00	4.0E+00
Annual dose (mrem) from rail transport		0.0E+00	1.6E-05	4.2E-03	4.15E-03	--	1.6E-05	4.2E-03	4.2E-03
Resources and Infrastructure									
Land area (% of available area)	(6)	79%	0.40%	1.48%	0.53%	--	79%	80%	79%
Water use (% capacity)		50%	0.01%	0.24%	0.02%	--	50%	50%	50%
Wastewater treatment (% capacity)		23%	0.12%	0.43%	0.13%	--	23%	23%	23%
Power demand (% current load)		51%	0.03%	0.40%	0.03%	--	51%	52%	51%
Employment									
Number of site workers	(7)	1,869	115	378	125	--	1,984	2,247	1,994
Air Quality Exceedance	(8)	Ozone	None	None	None	--	Ozone	Ozone	Ozone
Groundwater Quality Exceedance	(9)	15 parameters exceeded	None	Np-237	None	--	15 parameters exceeded	16 parameters exceeded	15 parameters exceeded

[a] Aside from continuation of existing operations, waste management, and environmental restoration activities, no other actions are planned by DOE at the Paducah Gas Diffusion Plant.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of site emission requirements. Waste management impacts presented indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

11.13.1 COMBINED WASTE MANAGEMENT IMPACTS

DOE considered the management of LLMW and LLW at the Pantex Plant. Table 11.13-1 lists the minimum and maximum combined impacts of the waste management alternatives considered for the Pantex Plant. The most adverse impacts at the Pantex Plant and in the Pantex Plant region would occur as a result of the Decentralized and Regionalized Alternatives for which treatment and disposal facilities would be constructed for LLMW and LLW. The least adverse impacts at the Pantex Plant and in the Pantex Plant region generally would result from the No Action Alternative and other Regionalized and Centralized Alternatives for which the Pantex Plant would prepare, package, and ship waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at Pantex are expected to be lower than the impacts of the maximum combined waste management alternatives at the site.

11.13.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at the Pantex Plant are described in separate EISs and include the storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), and continued operations (including environmental restoration activities) as described in a sitewide EIS (DOE, 1996i). In addition to these DOE actions, closures and realignment of military bases in the region could contribute to the cumulative impact of waste management alternatives. Table 11.13-2 identifies the range of cumulative impacts resulting from other actions described in the aforementioned EISs, the combined waste management alternatives, and existing activities.

As identified in Table 11.13-2, the maximum annual radioactive releases from the combined waste management alternatives (including transportation) would result in a slight increase in the dose to the offsite population from the Pantex Plant. However, maximum cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Table 11.13–1. Pantex Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population Health from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	2.2E–03	D,R1	6.9E–02	N	1.1E–06	D,R1	3.5E–05	R2-C	3.6E–10	N	7.0E–08
Low Level[a]	D-C5	8.8E–04	N	1.8E–03	D-C5	4.4E–07	N	8.8E–07	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.1E–03**		**7.1E–02**		**1.5E–06**		**3.5E–05**		**3.6E–10**		**7.0E–08**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	1.8E–07	D,R1	5.9E–06	N	9.2E–11	D,R1	2.9E–09	R2-C	3.0E–14	N	5.8E–12
Low Level[a]	D-C5	7.5E–08	N	1.5E–07	D-C5	3.7E–11	N	7.5E–11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.6E–07**		**6.1E–06**		**1.3E–10**		**2.9E–09**		**3.0E–14**		**5.8E–12**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D1,R1	0 / 0	R2-R4,C	40 / 30	N,D,R1	0.0E+00	R2-R4,C	6.4E–07	N,D,R1	0.0E+00	R2-R4,C	4.8E–07
Low Level	D,R1,R2	0 / 0	R5,C3,C4	430 / 170	D,R1,R2	0.0E+00	R5,C3,C4	6.9E–06	D,R1,R2	0.0E+00	R5,C3,C4	2.7E–06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**470 / 200**		**0.0E+00**		**7. 5–06**		**0.0E+00**		**3.2E–06**

Table 11.13-1. Pantex Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	4.7E-04	D,R1	6.9E-03	R2-C	2.3E-07	D,R1	3.5E-06	R2-C	4.1E-10	N	8.0E-08
Low Level[a]	D-C5	8.7E-05	N	1.7E-04	D-C5	4.4E-08	N	8.7E-08	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.6E-04**		**7.1E-03**		**2.8E-07**		**3.5E-06**		**4.1E-10**		**8.0E-08**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Min.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R2-C	0.3	D,R1	3.7
Low Level	All/None	All/None	All	None	All	None	N,R3-C5	1.7	R2	4.5
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**		**None**		**2.0**		**8.2**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	387	D,R1	4,499	N	305	D,R1	1,457	R2-C	0.16	D,R1	0.45
Low Level	N,R3-C5	1,977	R2	4,599	N,R3-C5	671	R2	3,691	N,R3-C5	0.19	R2	0.79
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2,364**		**9,098**		**976**		**5,148**		**0.35**		**1.24**

Table 11.13-1. Pantex Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.03	D,R1	0.17	N,R2-C	0.02	D,R1	0.07	N	38	D,R1	192
Low Level	N,R3-C5	0.12	R2	0.20	All	0.09	All	0.09	N,R3-C5	135	R2	222
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.15**		**0.37**		**0.11**		**0.16**		**173**		**414**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. The Pantex Plant does not have transuranic and high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.13-2. Pantex Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	0	3.10E-03	7.10E-02	6.99E-02	5.80E-03	8.90E-03	7.68E-02	7.57E-02
Number of cancer fatalities from collective dose	(2)	0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.00E-04	2.60E-05	6.10E-04	5.98E-04	5.00E-05	1.76E-04	7.60E-04	7.48E-04
Worker Population									
Collective dose, 10 years (person-rem)	(4)	3.00E+02	2.32E+00	5.00E+00	2.74E+00	4.93E+02	7.95E+02	7.98E+02	7.96E+02
Number of cancer fatalities from collective dose	(1)	1.50E-01	~0	~0	~0	2.47E-01	3.18E-01	3.19E-01	3.18E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	2,350	0	470	460	830	3,180	3,650	3,640
Number of rail shipments (10 yr)		0	0	200	190	0	0	200	190
Annual dose (mrem) from truck transport		9.4E-01	0.0E+00	7.5E-04	7.34E-04	3.3E-02	9.7E-01	9.7E-01	9.74E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	3.2E-04	3.08E-04	00E+00	0.0E+00	3.2E-04	3.08E-04
Resources and Infrastructure									
Land area (% of available area)	(6)	21%	0.02%	0.08%	0.06%	2%	23%	23%	23%
Water use (% capacity)		33%	0.16%	0.61%	0.43%	13%	46%	47%	47%
Wastewater treatment (% capacity)		50%	0.18%	0.94%	0.39%	24%	75%	75%	75%
Power demand (% current load)		0.8%	0.02%	0.08%	0.04%	0.77%	2%	2%	2%
Employment									
Number of site workers	(7)	3,011	77	125	107	968	4,056	4,104	4,086
Air Quality Exceedance	(8)	None	None	None	None	Alcohols	Alcohols	Alcohols	Alcohols
Groundwater Quality Exceedance	(9)	10 parameters exceeded	None	None	None	None	10 parameters exceeded	10 parameters exceeded	10 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), and continuation of sitewide operations (including the impacts of environmental restoration activities) (DOE, 1996i). Shipment numbers and shipment MEI values do not include those related to stockpile stewardship and management and continuation of sitewide operations because these were not presented in those EISs.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The Pantex Plant is in an attainment region where criteria air pollutants do not exceed standards. Although no air quality exceedances are expected for combined waste management activities, cumulative emissions for all activities at the site could result in the exceedance of the air quality standard for alcohols. Disposal of LLMW and LLW at Pantex are not expected to result in exceedance of standards for groundwater used as drinking water under any of the alternatives. No disposal of LLMW or LLW would occur at Pantex under the preferred alternatives.

The combined alternatives would affect between 2 and 8 acres of land at the Pantex Plant. This area is less than 1% of the total suitable acreage at Pantex and less than 1% of the area available for waste management facilities. Other actions could affect another 222 acres. Although the combined alternatives and other actions would only cumulatively affect a maximum of 2% of the suitable acreage at the Pantex Plant, detailed characterization studies and evaluations of the land may be required to ensure protection of wildlife habitats and cultural artifacts prior to development.

The demand for water and wastewater treatment would not be greatly affected nor would it exceed existing capacities because of the combined alternatives or the cumulative effects of other planned actions. Although cumulative power demand would increase as a result of other planned actions at the Pantex Plant, this increase would be well within current capacity, and no expansions or upgrades would be needed.

The combined alternatives could add up to 125 jobs at the Pantex Plant, while other actions could increase the number of jobs by 968. Cumulatively, the maximum number of jobs at the Pantex Plant would increase about 36%. Within the Pantex Plant region, about 2,080 jobs will be lost as a result of military base closures and realignments (DBCRC, 1995), and the potential employment increases at the Pantex Plant could offset some of these job losses. Mitigation measures may be required to reduce any adverse impacts to offsite community infrastructures and institutions.

11.14 Portsmouth Gaseous Diffusion Plant

Portsmouth Gaseous Diffusion Plant (PORTS) would continue in the future to produce enriched uranium. The existing environmental conditions at PORTS resulting from these ongoing activities are described Chapter 4.

11.14.1 COMBINED WASTE MANAGEMENT IMPACTS

DOE considered the management of LLMW and LLW at PORTS. Table 11.14–1 lists the minimum and maximum combined impacts of the waste management alternatives for PORTS. The most adverse impacts at PORTS and in the PORTS region would occur as a result of Regionalized Alternatives for which treatment and disposal facilities would be constructed for PORTS to manage its own waste, as well as accept offsite LLMW and LLW for treatment and disposal. The least adverse impacts at PORTS and in the PORTS region generally would result from other Regionalized and Centralized Alternatives for which PORTS would only prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at PORTS are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.14.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations, the waste management activities addressed in this PEIS, and environmental restoration actions, DOE has no other actions planned at PORTS. No other DOE or non-DOE actions are planned in the PORTS region that would contribute to the cumulative impact of the waste management alternatives.

The environmental restoration program at PORTS will address cleanup of an estimated 1,000,000 m^3 of contaminated media and facilities (270,000 m^3, 730,000 m^3 of LLMW and LLW, respectively; see Appendix B). Future cleanup actions include remediation of contaminated groundwater and soils and eventual decontamination and decommissioning of uranium enrichment facilities. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities at PORTS have had no significant adverse environmental impacts based on the NEPA and RCRA reviews completed to date. Future environmental evaluations will continue to be performed on a project-specific basis under RCRA and NEPA.

Table 11.14–2 identifies the range of cumulative impacts that would result from the combined waste management alternatives (including transportation) and current activities at PORTS. As identified in Table 11.14–2, the maximum annual radioactive releases that would result from the waste management alternatives would result in a very slight increase in the radiation dose to the offsite population; however,

Table 11.14-1. Portsmouth Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts

	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
Waste Type	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	3.6E-05	R2,3	2.1E-01	R4,C	1.8E-08	R2,3	1.1E-04	R4,C	4.9E-08	N	5.9E-05
Low Level[a]	D,R1	4.9E-07	R4, C3,4	3.8E+01	D,R1	2.4E-10	R4,C3,4	1.9E-02	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.6E-05**		**3.8E+01**		**1.8E-08**		**1.9E-02**		**4.9E-08**		**5.9E-05**

	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
Waste Type	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	4.5E-09	R2,3	2.6E-05	R4,C	2.2E-12	R2,3	1.3E-08	R4,C	8.2E-12	N	9.8E-09
Low Level[a]	D, R1	6.2E-11	R4,C3,4	4.6E-03	D,R1	3.1E-14	R4,C3,4	2.3E-06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4.9E-09**		**4.6E-03**		**2.E-12**		**2.3E-06**		**8.2E-12**		**9.8E-09**

	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
Waste Type	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R2,R3	2,260 / 960	N	0.0E+00	R2-R3	3.6E-05	N	0.0E+00	R2-R3	1.5E-05
Low Level	D	23,320 / 4,770	R4	47,610 / 18,410	D	3.7E-04	R4	7.7E-04	D	1.4E-04	R4	3.0E-04
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**23,320 / 4,770**		**49,870 / 19,370**		**3.7E-04**		**8.1E-04**		**1.4E-04**		**3.2E-04**

Table 11.14–1. Portsmouth Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	3.7E–06	R2,3	1.6E–02	R4,C	1.9E–09	R2,3	8.0E–06	R4,C	2.8E–08	N	3.3E–05
Low Level[a]	D,R1	5.1E–08	R4,C3,4	1.2E+00	D,R1	2.6E–11	R4,C3,4	5.9E–04	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.8E–06**		**1.2E+00**		**1.9E–09**		**6.0E–04**		**2.8E–08**		**3.3E–05**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R2-4,C	None	R1	2 hazardous chemicals[c]	N	1.3	R1	12.2
Low Level	All/None	All/None	All	None	All	None	R3,5-C2,5	2.0	R2	44.7
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[d]**	**None**		**None**		**2 hazardous chemicals[c]**		**3.3**		**56.9**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	2,190	R1	19,863	R4,C	1,888	R1	6,787	R4,C	0.37	R1	1.84
Low Level	R3,5-C2,5	3,997	R1	178,908	R3,5-C2,5	1,094	N	22,144	R3,5-C2,5	0.44	R1	26.84
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**6,187**		**198,771**		**2,982**		**28,931**		**0.81**		**28.68**

Table 11.14–1. Portsmouth Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.20	R1	0.98	N,R4,C	0.09	R1	0.36	N	210	R1	838
Low Level	R3,5-C2,5	0.20	R2	1.69	R3,5-C2,5	0.08	R2	0.62	R3,5-C2,5	169	R2	1,436
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		0.40		2.67		0.17		0.98		379		2,274

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Portsmouth does not have transuranic or high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Hazardous chemicals that could exceed standards for groundwater used as drinking water include 1,2-dichloroethane and methylene chloride.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.14-2. Portsmouth Gaseous Diffusion Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	3.00E-01	3.60E-05	3.80E+01	5.40E-03	--	3.00E+01	6.80E+01	3.00E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	--	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	2.60E-01	4.90E-07	4.60E-01	6.80E-05	--	2.60E-01	7.20E-01	2.60E-01
Worker Population									
Collective dose, 10 years (person-rem)	(4)	1.71E+03	1.31E+01	4.35E+02	1.46E+01	--	1.72E+03	2.15E+03	1.72E+03
Number of cancer fatalities from collective dose	(1)	6.84E-01	~0	1.74E-01	~0	--	6.89E-01	8.58E-01	6.90E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	2,600	23,320	49,870	34,090	--	25,920	52,470	36,690
Number of rail shipments (10 yr)		2,150	4,770	19,370	13,000	--	6,920	21,520	15,150
Annual dose (mrem) from truck transport		1.0E+00	3.7E-02	8.1E-02	5.50E-02	--	1.1E+00	1.1E+00	1.1E+00
Annual dose (mrem) from rail transport		8.6E-01	1.4E-02	3.2E-02	2.14E-02	--	8.7E-01	8.9E-01	8.8E-01
Resources and Infrastructure									
Land area (% of available area)	(6)	20%	0.08%	1.42%	0.31%	--	21%	21%	20%
Water use (% capacity)		38%	0.02%	0.54%	0.06%	--	38%	38%	38%
Wastewater treatment (% capacity)		29%	0.25%	2.41%	0.65%	--	29%	32%	30%
Power demand (% current load)		80%	0.04%	1.49%	0.11%	--	80%	81%	80%
Employment									
Number of site workers	(7)	2,582	153	927	400	--	2,582	3,509	2,982
Air Quality Exceedance	(8)	None	None	None	None	--	None	None	None
Groundwater Quality Exceedance	(9)	8 parameters exceeded	None	2 hazardous chemicals[e]	None	--	8 parameters exceeded	9 parameters exceeded	8 parameters exceeded

[a] Aside from the continuation of existing operations, waste management, and environmental restoration activities, no other actions are planned by DOE at the PORTS site.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed standards for groundwater used as drinking water include 1,2-dichloroethane and methylene chloride.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

PORTS is in an attainment region where criteria air pollutants do not exceed standards, and cumulative emissions are not expected to result in air quality standard exceedances. The combined alternatives would affect between 3 and 57 acres of land at PORTS. This area is about 1% of the total suitable acreage at PORTS and 2% of the area available for waste management facilities. Onsite infrastructure demands for water, wastewater treatment, and power would not greatly increase from the combined waste management alternatives and would remain within existing capacities. The combined alternatives could add up to 927 jobs, or a maximum employment increase of approximately 36%. The maximum increase in employment is not expected to affect offsite community infrastructures or institutions because of the current population and employment base in the region.

Disposal of LLMW at PORTS under Regionalized Alternative 1 could result in exceedances of standards for groundwater used as drinking water for 1,2-dichloroethane and methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at PORTS, nor are there any expected exceedances for other waste types. No disposal of LLMW would occur at PORTS under the preferred alternative.

11.15 Rocky Flats Environmental Technology Site

Rocky Flats Environmental Technology Site (RFETS) would continue in the future to conduct decontamination and decommissioning and cleanup. The existing environmental conditions at RFETS resulting from these ongoing activities are described in Chapter 4.

11.15.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at RFETS. Table 11.15–1 lists the minimum and maximum combined impacts of the waste management alternatives for RFETS. The most adverse impacts at RFETS and in the RFETS region would occur as a result of the No Action Alternative for LLMW and Regionalized Alternatives for which LLW treatment and disposal facilities would be

Table 11.15-1. Rocky Flats Environmental Technology Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	1.3E-02	N	2.6E+01	R4,C	6.3E-06	N	1.3E-02	R4,C	2.4E-06	N	1.0E-03
Low Level[a]	N	2.4E-04	R2,4,C3,4	3.7E-01	N	1.2E-07	R2,4,C3,4	1.9E-04	--	--	--	--
Transuranic	N	6.0E-03	R2	2.2E+02	N	3.0E-06	R2	1.1E-01	N	1.0E-10	R3,C	1.1E-09
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.9E-02**		**2.5E+02**		**9.4E-06**		**1.2E-01**		**2.4E-06**		**1.0E-03**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	1.7E-07	N	3.6E-04	R4,C	8.5E-11	N	1.8E-07	R4,C	1.9E-11	N	8.0E-09
Low Level[a]	N	3.3E-09	R2,4,C3,4	5.1E-06	N	1.6E-12	R2,4,C3,4	2.5E-09	--	--	--	--
Transuranic	N	8.2E-08	R2	3.0E-03	N	4.1E-11	R2	1.5E-06	All	<9.9E-14	All	<9.9E-14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.5E-07**		**3.4E-03**		**1.3E-10**		**1.7E-06**		**1.9E-11**		**8.0E-09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R2,R3	2,560 / 980	N	0.0E+00	R2,R3	4.1E-05	N	0.0E+00	R2,R3	1.6E-05
Low Level	D,R1, R2	0 / 0	R3,R6,R7, C1,C2 / R3, R5-R7 C1, C2	3,570 / 1,330	D,R1,R2	0.0E+00	R3,R6,R7, C1,C2	5.7E-05	D,R1,R2	0.0E+00	R3,R5-R7, C1,C2	2.1E-05
Transuranic	N	0 / 0	D	830 / 420	N	0.0E+00	D	1.2E-04	N	0.0E+00	D	1.3E-04
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**6,960 / 2,730**		**0.0E+00**		**2.2E-04**		**0.0E+00**		**1.7E-04**

Table 11.15–1. Rocky Flats Environmental Technology Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	6.4E-04	N	7.3E+00	R4,C	3.2E-07	N	6.7E-04	R4,C	4.8E-07	N	2.0E-04
Low Level	N	1.2E-05	R2,4,C3,4	1.9E-02	N	6.2E-09	R2,4,C3,4	9.5E-06	--	--	--	--
Transuranic	N	3.1E-04	R2	1.1E+01	N	1.5E-07	R2	5.6E-03	N	2.1E-11	R3,C	2.3E-10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.6-03**		**1.1E+01**		**8.0E-07**		**5.6E-03**		**4.8E-07**		**1.0E-05**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D-R3/CO;D-R1/NO_2	All/None	N,R2-4,C	None	D,R1	3 hazardous chemicals[c]	R4,C	6.2	D.R1	32.9
Low Level	All/None	All/None	All	None	All	None	N	1.1	R2	11.4
Transuranic	All/None	All/None	--	--	--	--	N	0	R2	2.8
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**CO, NO_2[d]**	**CO**		**None**		**3 hazardous chemicals[c]**		**8.5**		**47.1**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	7,271	D,R1	89,025	R4,C	3,478	D,R1	11,099	R4,C	0.86	D,R1	11.49
Low Level	N	2,490	R2	17,980	N	914	R2	11,997	N	0.20	D,R2	1.67
Transuranic	R3,C	2,173	R2	8,223	R3,C	708	R2	4,866	N	0.12	R2	0.87
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**11,934**		**115,228**		**5,100**		**27,962**		**1.51**		**14.03**

Table 11.15-1. Rocky Flats Environmental Technology Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	0.05	D,R1	0.14	R4,C	0.02	D,R1	0.07	R4,C	627	D,R1	1,826
Low Level	N,R3,5-C2,5	0.02	R2	0.08	N,R3,5-C2,5	0.01	R2	0.05	R3,5-C2,5	228	R2	1,044
Transuranic	R3,C	0.01	R2	0.04	R3,C	0.00	R1,2	0.02	R3,C	127	R2	531
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.08**		**0.26**		**0.03**		**0.14**		**982**		**3,401**

Notes: Alt. = alternative; C = Centralized Alternative; CO = carbon monoxide; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; NO_2 = nitrogen dioxide; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. The Rocky Flats Environmental Technology Site does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Hazardous chemicals that could exceed drinking water standards include carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

constructed to allow RFETS to manage its own waste. The least adverse impacts at RFETS and in the RFETS region generally would result from the Regionalized and Centralized Alternatives for which RFETS would only prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at RFETS are expected to be well below the impact of the maximum waste management alternatives at the site.

11.15.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operation and waste management activities addressed in this PEIS, reasonably foreseeable future actions at RFETS include the transfer of certain Nuclear Weapons Complex nonnuclear functions from RFETS to other sites (DOE, 1993); the operation of a supercompactor and TRUW shredder (DOE, 1990a); and environmental restoration activities. The impacts of the supercompactor and TRUW shredder are not included as future activities in the table because the operation of the supercompactor is considered part of the TRUW alternatives. In addition to these DOE actions, closure and realignment of military bases in the RFETS region could contribute to the cumulative impact of waste management alternatives. Table 11.15–2 identifies the range of cumulative impacts resulting from the combined waste management alternatives (including transportation), other actions, and current activities.

The environmental restoration program at RFETS will address cleanup of an estimated 480,900 m^3 of contaminated media and facilities (380,000 m^3, 96,000 m^3, and 4,900 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Future and ongoing cleanup actions include remediation of contaminated groundwater, solidification and disposition of solar pond sludge, and decontamination and decommissioning of facilities. The impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, but project-specific environmental evaluations will be performed prior to implementation.

As identified in Table 11.15–2, the annual radioactive releases that would result from the combined waste management alternatives (including transportation) would increase the radiation dose to the offsite population. However, the maximum cumulative radioactive release would be below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Table 11.15-2. Rocky Flats Environmental Technology Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts: Minimum	Combined Waste Management Impacts: Maximum	Combined Waste Management Impacts: Preferred Alternative	Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]: Minimum[c]	Cumulative Impacts[b]: Maximum[d]	Cumulative Impacts[b]: Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.40E+00	1.90-02	2.50E+02	2.00E-01	--	1.42E+00	2.51E+02	1.60E+00
Number of cancer fatalities from collective dose	(2)	~0	~0	1.25E-01	~0	--	~0	1.26E-01	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	2.00E-04	2.50E-05	3.40E-01	2.66E-04	--	2.25E-04	3.40E-01	4.66E-04
Worker Population									
Collective dose, 10 years (person-rem)	(4)	Not available	5.61E+00	9.23E+01	2.44E+01	--	5.61E+00	9.20E+01	2.44E+01
Number of cancer fatalities from collective dose	(1)		~0	~0	~0	--	~0	~0	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	210	0	6,960	6,920	--	210	7,170	7,130
Number of rail shipments (10 yr)		0	0	2,730	2,690	--	0	2,730	2,690
Annual dose (mrem) from truck transport		8.4E-02	0.0E+00	2.2E-02	2.17E-02	--	8.4E-02	1.1E-01	1.1E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.7E-02	1.66E-02	--	0.0E+00	1.7E-02	1.7E-02
Resources and Infrastructure									
Land area (% of available area)	(6)	15%	0.13%	0.69%	0.56%	--	15%	16%	16%
Water use (% capacity)		27%	1.19%	11.52%	9.89%	--	28%	39%	37%
Wastewater treatment (% capacity)		30%	1.02%	5.59%	3.16%	--	31%	36%	33%
Power demand (% current load)		53%	4.38%	40.67%	36.00%	--	57%	94%	89%
Employment									
Number of site workers	(8)	7,962	272	1,369	774	-715	7,519	8,616	8,736
Air Quality Exceedance	(9)	PM_{10}, CO, ozone	None	CO, NO_2	CO, NO_2	--	PM_{10}, CO, ozone	PM_{10}, CO, NO_2, ozone	PM_{10}, CO, NO_2, ozone
Groundwater Quality Exceedance	(6)	12 parameters exceeded	None	3 hazardous chemicals[e]	None	--	13 parameters exceeded	14 parameters exceeded	13 parameters exceeded

[a] Other reasonably foreseeable future actions include the transfer of non-nuclear functions from RFETS to other sites (DOE, 1993). Impacts of proposed TRUW supercompactor are included within waste management alternatives for TRUW.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed standards for groundwater used as drinking water include carbon tetrachloride, 1,2-dichloroethane, and methylene chloride,

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

RFETS is in a nonattainment region where criteria air pollutants are exceeded for particulates, carbon monoxide, and ozone. While minimum cumulative emissions would not exceed air quality standards, cumulative emissions with maximum combined alternatives or the preferred alternatives are expected to result in exceedances of both carbon monoxide and nitrogen dioxide emission limits as a result of the construction of LLMW facilities and for carbon monoxide alone for operation of facilities. Measures to mitigate these emissions would be necessary if these alternatives were chosen.

The combined alternatives would affect between 9 and 47 acres of land. This area is less than 1% of the total suitable acreage at RFETS and less than 1% of the area available for waste management facilities. Although the combined alternatives would result in increases in the demands for water, wastewater treatment, and power, the existing capacities for these utilities are expected to be sufficient.

The combined alternatives could add up to 1,369 jobs at RFETS, while the transfer of nonnuclear functions from RFETS would reduce employment by 715 jobs. Within the RFETS region, about 2,900 jobs will be lost as a result of military base closures and realignments (DBCRC, 1995). The potential employment increase at RFETS would offset some of the job losses, and no mitigation is expected to be necessary to reduce adverse impacts to offsite infrastructures and institutions.

Disposal of LLMW at RFETS under the Decentralized Alternative and Regionalized Alternative 1 could result in exceedances of drinking water standards in groundwater for carbon tetrachloride, 1,2-dichloroethane, and methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at RFETS, nor are there any expected exceedances for other waste types. No disposal of LLMW would occur at RFETS under the preferred alternatives.

11.16 Sandia National Laboratories

Sandia National Laboratories in New Mexico (SNL-NM) would continue in the future to develop, engineer, and test nonnuclear components of nuclear weapons. The existing environmental conditions at SNL-NM resulting from these ongoing activities are described in Chapter 4.

11.6.1 COMBINED WASTE MANAGEMENT IMPACTS

DOE considered the management of LLMW, LLW, and TRUW at SNL-NM. Table 11.16–1 lists the minimum and maximum combined impacts of the waste management alternatives for SNL-NM. As noted in Table 11.16–1, SNL-NM has a very small quantity of TRUW, and impacts are expected to be minimal for all TRUW alternatives affecting SNL-NM. The most adverse impacts at SNL-NM and in the SNL-NM region would occur as a result of the Decentralized Alternatives for which treatment and disposal facilities would be constructed to allow SNL-NM to manage its own waste. The least adverse impacts would result from the Regionalized and Centralized Alternatives for which SNL-NM would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at SNL-NM are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

11.16.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at SNL-NM include the transfer of certain Nuclear Weapons Complex nonnuclear functions to SNL-NM (DOE, 1993), stockpile stewardship and management (DOE 1996f), medical isotope production (DOE, 1996c), and environmental restoration activities (DOE, 1996k). Table 11.16–2 identifies the range of cumulative impacts resulting from the combined alternatives, the confirmed transfer of nonnuclear functions to SNL-NM, and current activities.

As identified in Table 11.16–2, the annual radioactive releases that would result from the combined waste management alternatives would result in a slight increase in the current radiation dose to the offsite population. However, the maximum cumulative radioactive release would remain well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

SNL-NM is in a nonattainment region for carbon monoxide; however, both minimum and maximum combined emissions would not exceed air quality standards. The combined alternatives would affect between 1 and 5 acres of land. This area is approximately 1% of the total suitable acreage at SNL-NM and about 2% of the area available for waste management facilities. Other future actions could affect another 1,123 acres. Onsite infrastructure demands for water, wastewater treatment, and power would not

Table 11.16–1. Sandia National Laboratories-New Mexico Range of Combined Waste Management Alternative Impacts

	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
Waste Type	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	3.6E–05	D	2.8E–01	R1-C	1.8E–08	D	1.4E–04	R1-C	5.4E–10	N	7.3E–07
Low Level[a]	N	3.4E–03	D-C5	3.6E–03	N	1.7E–06	D-C5	1.8E–06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.4E–03**		**2.8E–01**		**1.7E–06**		**1.4E–04**		**5.4E–10**		**7.3E–07**

	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
Waste Type	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.4E–09	D	1.1E–05	R1-C	7.1E–13	D	5.4E–09	R1-C	2.3E–14	N	3.1E–11
Low Level[a]	All	1.4E–07	All	1.4E–07	N	6.8E–11	R1-C5	7.2E–11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.4E–07**		**1.1E–05**		**6.9E–11**		**5.5E–09**		**2.3E–14**		**3.1E–11**

	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
Waste Type	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D	0 / 0	R1-R4, C	20 / 20	N,D	0.0E+00	R1-R4,C	3.20E–07	N,D	0.0E+00	R1-R4,C	3.2E–07
Low Level	D	0 / 0	N,R5,C3, C4 / N	240 / 120	D	0.0E+00	N,R5,C3, C4	3.90E–06	D	0.0E+00	N	1.9E–06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**260 / 140**		**0.0E+00**		**4.2E–06**		**0.0E+00**		**2.2E–06**

Table 11.16–1. Sandia National Laboratories (New Mexico) Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	6.9E–07	D	1.6E–03	R1-C	3.5E–10	D	7.8E–07	R1-C	6.0E–11	N	8.1E–08
Low Level[a]	N	5.8E–05	D-C5	6.1E–05	N	2.9E–08	D-C5	3.0E–08	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.9E–05**		**1.7E–03**		**2.9E–08**		**8.1E–07**		**6.0E–11**		**8.1E–08**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Min.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	N,R1-C	None	D	Pu-240	N,R1-C	0.0	D	1.7
Low Level	All/None	All/None	N,R1-C5	None	D	5 radio-nuclides[c]	N	0.9	D	3.0
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[d]**	**None**		**None**		**5 radio-nuclides[c]**		**0.9**		**4.7**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,R1-C	18	D	2,079	N,R1-C	18	D	289	N,R1-C	0.01	D	0.15
Low Level	N	1,077	D	3,675	N	622	D	1,146	N	0.12	D	0.39
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1,095**		**5,754**		**640**		**1,435**		**0.13**		**0.54**

Table 11.16–1. Sandia National Laboratories (New Mexico) Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	0.00	D	0.02	N,R1-C	0.00	D	0.07	R1-C	6	D	73
Low Level	N	0.02	D	0.06	N,R1-C	0.01	D	0.03	R1-C5	108	D	243
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.02**		**0.08**		**0.01**		**0.10**		**114**		**316**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Sandia National Laboratories, which includes the Inhalation Toxicology Research Institute, has a de minimis quantity of transuranic waste and does not have high-level waste. No new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Radionuclides that could exceed drinking water standards in groundwater include Pu-239, Pu-240, Tc-99, U-234, and U-238.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.16–2. Sandia National Laboratories-New Mexico Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts: Minimum	Combined Waste Management Impacts: Maximum	Combined Waste Management Impacts: Preferred Alternative	Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]: Minimum[c]	Cumulative Impacts[b]: Maximum[d]	Cumulative Impacts[b]: Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	2.00E-01	3.44E-03	2.84E-01	2.84E-01	1.30E+02	1.30E+02	1.30E+02	1.30E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	3.40E-03	1.40E-05	1.11E-03	1.11E-03	1.75E-01	1.78E-01	1.80E-01	1.80E-01
Worker Population									
Collective dose, 10 years (person-rem)	(4)	3.50E+01	1.04E+00	2.15E+02	1.82E+00	2.50E+02	2.86E+02	5.00E+02	2.87E+02
Number of cancer fatalities from collective dose	(1)	~0	~0	~0	~0	1.00E-01	1.14E-01	2.00E-01	1.15E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	60	0	380	370	16,100	16,160	16,540	16,530
Number of rail shipments (10 yr)		0	0	200	180	0	0	200	180
Annual dose (mrem) from truck transport		2.4E-02	0.0E+00	7.5E-04	7.28E-04	6.1E-01	6.3E-01	6.3E-01	6.3E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	6.0E-04	5.72E-04	0.0E+00	0.0E+00	6.0E-04	5.7E-04
Resources and Infrastructure									
Land area (% of available area)	(6)	6%	0.04%	0.18%	0.13%	40%	46%	46%	46%
Water use (% capacity)		25%	0.03%	0.14%	0.11%	17%	42%	42%	42%
Wastewater treatment (% capacity)		95%	0.11%	0.25%	0.16%	36%	131%	131%	131%
Power demand (% current load)		69%	0.26%	1.08%	0.78%	18%	87%	88%	88%
Employment									
Number of site workers	(7)	8,596	23	107	46	1,726	10,345	10,429	10,368
Air Quality Exceedances	(8)	CO	None	None	None	None	CO	CO	CO
Water Quality Exceedances	(9)	5 parameters exceeded	None	5 radio-nuclides[e]	None	None	5 parameters exceeded	10 parameters exceeded	5 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to stockpile stewardship and management (DOE, 1996f), transfer of non-nuclear functions (DOE, 1993), medical isotope production (DOE, 1996c) and environmental restoration activities (DOE, 1996k).

[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.

[c] Cumulative impacts, including minimum combined waste management impacts.

[d] Cumulative impacts including maximum combined waste management impacts.

[e] Radionuclides that could exceed drinking water standards in groundwater include Pu-239, Pu-240, Tc-99, U-234, and U-238.

Notes:

(1) Assumes all facilities operate concurrently for the same 10-year period.

(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).

(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.

(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.

(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.

(6) Suitable land includes land that is available for development or land that is currently developed.

(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.

(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements.

(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

measurably increase from the combined waste management alternatives, but wastewater treatment capacity would be exceeded as a result of other actions planned at SNL-NM and would require upgrades.

The combined waste management alternatives could add up to 107 jobs at SNL-NM, while other actions would add an additional 1,726 jobs. The cumulative increase would be about 21% over existing employment at SNL-NM, which is not expected to affect offsite community infrastructures and institutions.

Disposal of LLW at SNL-NM under the Decentralized Alternative could result in exceedances of standards for groundwater used as drinking water for Pu-239, Pu-240, Tc-99, U-234, and U-238. For disposal of LLMW, the Decentralized Alternative could also result in an exceedance for Pu-240. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLW or LLMW are expected to result in exceedances for any contaminant at SNL-NM, nor are there any expected exceedances for other waste types. No disposal of LLMW or LLW would occur at SNL-NM under the preferred alternatives.

11.17 Savannah River Site

Savannah River Site (SRS) would continue in the future to conduct defense program missions, including those for tritium and special nuclear materials. The existing environmental conditions at SRS resulting from these ongoing activities are described in Chapter 4.

11.17.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, HLW, and HW at SRS. Table 11.17–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for SRS. The most adverse impacts at SRS and in the SRS region would occur as a result of some Centralized and Regionalized Alternatives for which treatment and disposal facilities would be constructed for SRS to manage its own LLW and LLMW, in addition to accepting offsite LLMW and LLW for treatment and disposal, offsite TRUW for treatment, and offsite HLW canisters for storage. The least adverse impacts generally would result from other Regionalized and Centralized Alternatives for which SRS would only prepare, package, and ship waste for offsite treatment and disposal. For most impact categories, the

Table 11.17–1. Savannah River Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	2.7E-03	D-R4	3.5E+00	C	1.3E-06	R1-R4	1.8E-03	C	6.1E-08	N	2.9E-06
Low Level[a]	C5	2.5E-02	N,R2,4,5, C3,4	1.2E+00	C5	1.2E-05	R2,4,5, C3,4	6.1E-04	--	--	--	--
Transuranic	N	4.3E-02	R2,3	4.5E+00	N	2.2E-05	R2,3	2.3E-03	N	7.2E-13	R1	3.1E-11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	D	1.3E-03
Total		7.1E-02		9.2E+00		3.5E-05		4.7E-03		6.1E-08		1.3E-03

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	2.5E-08	D-R4	3.3E-05	C	1.3E-11	D-R4	1.7E-08	C	7.9E-13	N	3.7E-11
Low Level[a]	C5	2.3E-07	N,R2,4,5	1.1E-05	C5	1.2E-10	R2,4,5, C3,4	5.7E-09	--	--	--	--
Transuranic	N	4.1E-07	R2,3	4.2E-05	N	2.0E-10	R2,3	2.1E-08	All	<9.9E-14	All	<9.9E-14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	D	1.7E-08
Total		6.7E-07		8.6E-05		3.3E-10		4.4E-08		7.9E-13		1.7E-08

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R3	710 / 330	N	0.0E+00	R3	1.1E-05	N	0.0E+00	R3	5.3E-06
Low Level	D,R1-R5	20 / 10	R6,R7	130,030 / 49,340	D,R1-R5	3.2E-07	R6,R7	2.1E-03	D,R1-R5	1.6E-07	R6,R7	7.9E-04
Transuranic	N	0 / 0	D	2,370 / 1,190	N	0.0E+00	D	3.5E-04	N	0.0E+00	D	3.6E-04
High Level	N,D,R2,C1,C2	4,572 / 915	R1	5,252 / 1,051	N,D,R2, C1,C2	1.8E-03	R1	2.1E-03	N,D,R2, C1,C2	3.7E-04	R1	4.2E-04
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		4,592 / 925		138,362 / 51,911		1.8E-03		4.6E-03		3.7E-04		1.6E-03

Table 11.17-1. Savannah River Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	1.3E-04	N	1.3E-01	C	6.5E-08	N	6.5E-05	C	3.1E-08	N	1.4E-06
Low Level[a]	C5	2.2E-03	C3,4	6.7E-02	C5	1.1E-06	R2,4,5, C3,4	3.3E-05	--	--	--	--
Transuranic	N	4.7E-03	R2,3	4.8E-01	N	2.3E-06	R2,3	2.4E-04	N	3.6E-13	R1-3	1.5E-11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	0.0E+00	D	6.5E-04
Total		6.9E-03		6.8E-01		4.1E-06		3.4E-04		3.1E-08		6.5E-04

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R3,C	None	D,R1,2,4	4 hazardous chemicals[c]	R3,C	12.8	N	24.9
Low Level	All/None	All/None	C1-C5	--	N,D,R1-7	U-238	C1,2,5	12.5	R6,7	82.5
Transuranic	All/None	All/None	--	--	--	--	N	0	R2,3	8.2
High Level	All/None	All/None	--	--	--	--	N,D,R2,C	2.0	R1	4.0
Hazardous	All/None	All/None	--	--	--	--	N,R2	--	R1	1.0
Total	None[d]	None		None		4 hazardous chemicals,[e] U-238		27.3		120.6

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	2,832	N	74,593	C	1,053	R1,2	8,980	R3,C	1.41	N	10.46
Low Level	N	13,690	R6,7	174,220	C1,2,5	7,911	R6,7	40,247	N	5.31	R6,7	9.77
Transuranic	N	1,973	R2,3	22,118	C	847	R2,3	7,366	N	0.07	R2,3	1.17
High Level	N,C	1,900	D-R2	1,930	N,C	1,900	D-R2	1,930	All	0.05	All	0.05
Hazardous	N,R2	--	R1	593	N,R2	--	R1	371	N,R2	--	D,R1	0.13
Total		20,395		273,454		11,711		58,894		6.84		21.58

Table 11.17-1. Savannah River Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	0.09	R1,2,4	0.46	C	0.04	R1,2,4	0.32	C	253	R1,2,4	1,245
Low Level	C1,2,5	0.40	R6,7	2.48	C1,2,5	0.19	R6,7	1.33	C1,2,5	1,066	R6,7	6,630
Transuranic	N	0.05	R2,3	0.38	N	0.02	R2,3	0.16	N	161	R2,3	1,024
High Level	C	0.06	D,R2	0.13	All	0.03	All	0.03	C	283	R1	594
Hazardous	N,R2	--	R1	0.01	N,R2	--	R1	0.00	R2	--	R1	32
Total		0.60		3.46		0.25		1.84		1,763		9,525

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

[e] Hazardous chemicals that could exceed drinking water standards in groundwater include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

combined impacts of the preferred alternatives at SRS are expected to be lower than the impacts of the maximum combined management alternatives at the site.

11.17.2 CUMULATIVE IMPACTS

Aside from the waste management activities addressed in this PEIS, reasonably foreseeable future actions at SRS include continued management of spent nuclear fuels (DOE, 1995d), tritium supply and recycling (DOE, 1995a), transfer of Nuclear Weapons complex nonnuclear functions to SRS (DOE, 1993), processing of F-Canyon plutonium solutions to plutonium metal (DOE, 1994g), interim management of nuclear materials (DOE, 1995b), operation of the Defense Waste Processing Facility (DOE, 1994h), other site projects for the management of waste (including environmental restoration activities) (DOE, 1995c), storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), and disposition of surplus highly enriched uranium (DOE, 1995f).

Table 11.17–2 identifies the range of cumulative impacts resulting from these other actions, the combined waste management alternatives, and current activities that include atmospheric radiological releases from the Vogtle Nuclear Power Plant, located near SRS. Table 11.17–2 does not include, under the category of Other Actions, the impacts of waste management projects considered in the SRS Waste Management EIS (DOE, 1995c) because these are also included in the alternatives in this WM PEIS. Table 11.17–2 includes the impacts of SRS managing aluminum-clad spent nuclear fuel, as recently decided by DOE and evaluated in DOE (1995d).

As identified in Table 11.17–2, the maximum annual cumulative radioactive releases would result in an increase in the radiation dose to the offsite population. The maximum cumulative increase in radioactive releases would primarily result from the treatment of TRUW and releases associated with tritium production and recycling. Maximum cumulative radioactive releases would continue to be below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

SRS is in an attainment region where criteria air pollutants do not exceed standards. The cumulative emissions resulting from the existing operations, combined waste management alternatives, and other future actions are not expected to result in air quality standard exceedances.

Table 11.17-2. Savannah River Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	6.40E+01	7.10E-02	9.20E+00	3.81E+00	2.90E+03	2.96E+03	2.97E+03	2.96E+03
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	1.45E+00	1.48E+00	1.48E+00	1.48E+00
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.40E-01	6.70E-05	8.60E-03	3.59E-03	3.76E+00	3.90E+00	3.91E+00	3.90E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	3.50E+03	2.65E+03	5.76E+03	4.93E+03	1.16E+04	1.77E+04	2.08E+04	2.00E+04
Number of cancer fatalities from collective dose	(1)	1.40E+00	1.06E+00	2.30E+00	1.97E+00	4.63E+00	7.09E+00	8.33E+00	8.00E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	580	4,592	138,362	74,862	1,349	6,521	140,291	76,791
Number of rail shipments (10 yr)		0	925	51,911	27,275	422	1,347	52,333	27,697
Annual dose (mrem) from truck transport		2.3E-01	1.8E-01	4.6E-01	3.10E-01	5.2E-02	4.6E-01	7.4E-01	5.9E-01
Annual dose (mrem) from rail transport		0.0E+00	3.7E-02	1.6E-01	9.75E-02	1.6E-02	5.3E-02	1.7E-01	1.1E-01
Resources and Infrastructure									
Land area (% of available area)		10%	0.02%	0.07%	0.05%	0.31%	10%	10%	10%
Water use (% capacity)	(6)	32%	0.41%	5.47%	3.23%	103%	136%	141%	139%
Wastewater treatment (% capacity)		67%	1.56%	7.85%	5.79%	50%	119%	125%	123%
Power demand (% current load)		74%	3.91%	12.33%	5.69%	213%	291%	300%	293%
Employment									
Number of site workers	(7)	19,201	483	3,216	2,406	3,499	23,183	25,916	25,106
Air Quality Exceedances	(8)	None	None	None	None	None	None	None	None
Water Quality Exceedances	(9)	42 parameters exceeded	None	4 hazardous chemicals,[e] U-238	4 hazardous chemicals,[e] U-238	None	42 parameters exceeded	43 parameters exceeded	43 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to defense waste processing (DOE, 1994h), tritium supply and recycle (DOE, 1995a), spent nuclear fuel management (including spent nuclear fuel form foreign research reactors) (DOE, 1995d), other site-specific waste management actions (including environmental restoration activities) (DOE, 1994c), F-Canyon (DOE, 1994g), interim management of nuclear materials (DOE, 1995b), storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), transfer of non-nuclear functions (DOE, 1993), and disposition of highly enriched uranium (DOE 1995f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed drinking water standards in groundwater include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

Notes:
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined waste management alternatives would affect between 25 and 119 acres of land at SRS. This area is less than 1% of the total suitable acreage at SRS and less than 1% of the area available for waste management facilities. Other actions could affect another 500 acres. Although the combined alternatives and other actions would only cumulatively affect a maximum of less than 1% of the suitable acreage at SRS, detailed characterization studies and evaluations of that land may be required to ensure protection of wildlife habitats and cultural artifacts.

The maximum demand for water, wastewater treatment, and power resulting from the combined alternatives would not exceed 13% of existing capacities and would not require upgrades or expansion of existing capacities. Cumulatively, water, wastewater, and power capacities at SRS would require improvements (expansions or upgrades) from the increased demands resulting from other actions planned at SRS.

The combined alternatives could add up to 3,216 jobs at SRS, while other actions could also increase the number of jobs at SRS by up to 3,499. Cumulatively, the number of jobs at SRS could increase by 35%, which could affect existing offsite community infrastructures and institutions. Such an increase could require mitigation to reduce any adverse offsite infrastructure and institutional impacts.

Disposal of LLMW at SRS under the Decentralized Alternative and Regionalized Alternatives 1, 2, and 4 (including the preferred alternative for LLMW) could result in exceedances of drinking water standards for groundwater for U-238, benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride. The No Action Alternative, Decentralized Alternative, and Regionalized Alternatives 1 through 7 (including the preferred alternative for LLW) could, in addition, result in exceedances in U-238 for disposal of LLW. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. Other alternatives for LLMW or LLW are not expected to result in exceedances for any contaminants at SRS.

11.18 Waste Isolation Pilot Plant

The only alternative being considered for the Waste Isolation Pilot Plant (WIPP) is the possible treatment of all contact-handled TRUW under the TRUW Centralized Alternative. Table 11.18–1 lists the impacts of this alternative for WIPP. The preferred alternative for WIPP would have treatment of TRUW occurring elsewhere.

Table 11.18–1. Waste Isolation Pilot Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	5.2E+02	N,D-R3	--	C	2.6E-01	N,D-R3	--	C	5.5E-10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**5.2E+02**		**0**		**2.6E-01**		**0**		**5.5E-10**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	1.4E-01	N,D-R3	--	C	6.9E-05	N,D-R3	--	C	2.1E-13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
										0		
Total		**0**		**1.4E-01**		**0**		**6.9E-05**				**2.1E-13**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses in Person-Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N	0 / 0	D	23,860 / 11,970	N	0.0E+00	D	3.1E-03	N	0.0E+00	D	3.1E-03
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**23,860 / 11,970**		**0.0E+00**		**3.1E-03**		**0.0E+00**		**3.1E-03**

Table 11.18–1. Waste Isolation Pilot Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	4.2E+01	N,D-R3	--	C	2.1E–02	N,D-R3	--	C	2.8E–10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**4.2E+01**		**0**		**2.1E–02**		**0**		**2.8E–10**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--
Transuranic	All/None	All/None	--	--	--	--	N,D-R3	--	C	8.8
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**		**None**		**0**		**8.8**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	41,429	N,D-R3	--	C	15,204	N,D-R3	--	C	3.5
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**41,429**		**0**		**15,204**		**0**		**3.5**

Table 11.18-1. Waste Isolation Pilot Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	2.05	N,D-R3	--	C	0.64	N,D-R3	--	C	2,346
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		0		2.05		0		0.64		0		2,346

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001

[a] The Waste Isolation Pilot Plant does not have low-level mixed, low-level, or high-level waste, and no hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

WIPP is the candidate location for a geologic repository for DOE TRUW. The potential impacts of TRUW disposal at WIPP have been assessed in previous EISs (DOE, 1980; DOE, 1990b) and in the supplemental EIS that is currently being prepared by DOE (DOE, 1996m). Table 11.18–2 identifies the range of cumulative impacts resulting from the possible treatment and disposal of TRUW at WIPP. No other DOE or non-DOE actions are planned at WIPP or in the WIPP vicinity that would contribute to the cumulative impact of waste management alternatives.

As identified in Table 11.18–2, the annual cumulative radioactive releases could result in an increase in radiation dose to the offsite population and, without mitigation, the maximum increase in radioactive releases could exceed the EPA standard of 10 millirems per year to the maximally exposed individual offsite. The preferred alternative would not result in such an exceedance.

WIPP is located an attainment region where criteria air pollutants do not exceed standards. The maximum air emissions, other than radioactive emissions, are not expected to result in air quality standard exceedances.

Treatment of contact-handled TRUW at WIPP would affect 9 acres of land. This area is less than 1% of the total suitable acreage at WIPP and less than 1% of the area available for waste management facilities. Facilities for disposal could affect 150 acres. These actions cumulatively would affect about 2% of the suitable acreage at WIPP, and detailed characterization studies and evaluations of this land may be required to ensure protection of wildlife habitats and cultural resources.

The maximum cumulative demand for water would not measurably affect existing usage or capacity. The treatment and disposal of TRUW would individually and cumulatively require increases in wastewater treatment capacity, however. In addition, treatment of TRUW could add up to 459 jobs at WIPP and could impact existing offsite community infrastructures and institutions. Such an increase could require mitigation to reduce any adverse offsite infrastructure and institutional impacts.

Table 11.18-2. Waste Isolation Pilot Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts: Minimum	Combined Waste Management Impacts: Maximum	Combined Waste Management Impacts: Preferred Alternative	Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]: Minimum[c]	Cumulative Impacts[b]: Maximum[d]	Cumulative Impacts[b]: Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	0.0E+00	0.0E+00	5.20E+02	0.00E+00	2.00E-01	2.00E-01	5.20E+02	2.00E-01
Number of cancer fatalities from collective dose	(2)	0	0	2.60E-01	0.00E+00	~0	~0	2.60E-01	1.00E-04
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	0.0E+00	0.0E+00	1.40E+01	0.00E+00	2.00E-02	2.00E-02	1.4E+01	2.00E-02
Worker Population									
Collective dose, 10 years (person-rem)	(4)	0.0E+00	0.0E+00	4.10E+01	0.00E+00	3.00E+02	3.00E+02	3.41E+02	3.00E+02
Number of cancer fatalities from collective dose	(1)	0	0	~0	0.00+00	1.20E-01	1.20E-01	1.36E-01	1.20E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	0	0	23,860	23,860	0	0	23,860	23,860
Number of rail shipments (10 yr)		0	0	11,970	11,970	0	0	11,970	11,970
Annual dose (mrem) from truck transport		0.0E+00	0.0E+00	3.1E-01	3.10E-01	0.0E+00	0.0E+00	3.1E-01	3.10E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	3.1E-01	3.10E-01	0.0E+00	0.0E+00	3.1E-01	3.10E-01
Resources and Infrastructure									
Land area (% of available area)	(6)	0.34%	0.00%	0.09%	0.00%	1.46%	1.81%	1.89%	1.81%
Water use (% capacity)		0.87%	0.00%	0.48%	0.00%	0.0%	0.87%	1.35%	0.87%
Wastewater treatment (% capacity)		65%	0.00%	82.20%	0.00%	0.0%	65%	147%	65%
Power demand (% current load)		49%	0.00%	37.02%	0.00%	0.0%	49%	86%	49%
Employment									
Number of site workers	(7)	932	22	459	22	163	1,117	1,554	1,117
Air Quality Exceedances	(8)	None	None	Radiation	None	None	None	Radiation	None
Groundwater Quality Exceedances	(9)	6 parameters exceeded	None	None	None	None	6 parameters exceeded	6 parameters exceeded	6 parameters exceeded

[a] Other reasonably foreseeable future actions include startup of disposal operations as described in the draft WIPP Supplemental EIS (DOE, 1996m).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts including maximum combined waste management impacts.

Notes:
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers.
(5) Maximum exposed individual to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. For the WIPP site, all six constituents are naturally high and do not result from any activities at the site. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

11.19 West Valley Demonstration Project

The West Valley Demonstration Project (WVDP) began operations as a nuclear fuel reprocessing plant in 1966 and was shut down in the late 1970s. DOE plans to decommission WVDP in the near future. The existing environmental conditions at WVDP resulting from past activities are described in Chapter 4.

11.19.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, and HLW at WVDP. Table 11.19-1 lists the minimum and maximum combined impacts of the waste management alternatives considered for WVDP. WVDP has very small quantities of both LLW and TRUW, and impacts associated with these two waste types are expected to be minimal. The most adverse impacts at WVDP and in the WVDP region would occur as a result of the No Action and Decentralized Alternatives for which treatment and disposal facilities would be located at WVDP to manage its own waste. The least adverse impacts at WVDP and in the WVDP region generally would result from the Regionalized and Centralized Alternatives for which WVDP would only prepare, package, and ship its waste for offsite treatment and disposal.

11.19.2 Cumulative Impacts

Additional actions to occur at WVDP include the vitrification of HLW, which was previously assessed in an EIS (DOE, 1982a), and completion and closure activities that have been assessed in a separate EIS (DOE, 1996h). No other DOE or non-DOE actions are planned at WVDP or in the WVDP region. Table 11.19-2 identifies the range of cumulative impacts at WVDP.

As identified in Table 11.19-2, the maximum annual cumulative radioactive releases would result in an increase in radiation dose to the offsite population. The maximum cumulative increase in radioactive releases would continue to be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Table 11.19–1. West Valley Demonstration Project Range of Combined Waste Management Alternative Impacts[a]

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1,2,3	3.4E–04	N	2.7E–01	R1,2,3	1.7E–07	N	1.4E–04	R1-C	4.5E–09	N	1.5E–07
Low Level[a]	D	2.5E–03	N	7.1E–03	D	1.2E–06	N	3.5E–06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.8E–03**		**2.8E–01**		**1.4E–06**		**1.4E–04**		**4.5E–09**		**1.5E–07**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	5.2E–09	N	4.1E–06	R1-C	2.6E–12	N	2.1E–09	R1-C	1.5E–13	N	5.0E–12
Low Level[a]	D	3.7E–08	N	1.1E–07	D	1.9E–11	N	5.3E–11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4.2E–08**		**4.2E–06**		**2.2E–12**		**2.1E–09**		**1.5E–13**		**5.0E–12**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	D	100 / 100	N	0.0E+00	D	1.60E–06	N	0.0E+00	D	1.6E–06
Low Level	D	0 / 0	R1,R3,R6, R7,C1,C2	6,620 / 2,480	D	0.0E+00	R1,R3,R6, R7,C1,C2	1.10E–04	D	0	R1,R3,R6, R7,C1,C2	4.0E–05
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	All	340 / 68	All	340 / 68	All	1.40E–04	All	1.40E–04	All	2.7E–05	All	2.7E–05
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**340 / 68**		**7,060 / 2,648**		**1.40E–04**		**2.5E–04**		**2.7E–05**		**6.9E–05**

Table 11.19–1. West Valley Demonstration Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1,2,3	4.4E–07	N	6.7E–04	R1,2,3	2.2E–10	N	3.4E–07	R1,2,3	8.9E–11	N	3.0E–09
Low Level[a]	D	5.1E–06	N	1.5E–05	D	1.5E–11	N	7.5E–09	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.6E–06**		**6.9E–04**		**2.4E–10**		**3.5E–07**		**8.9E–11**		**3.0E–09**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	--	--	--	--	N	0.4	D	1.5
Low Level	--	--	--	--	--	--	N,R1-C5	4.0	D	18
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level	All/None	All/None	--	--	--	--	All	--	All	--
Hazardous[a]	--	--	--	--	--	--	--	--		--
Total	None[c]	None		None		None		**4.4**		**19.5**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	229	D	1,925	N	18	D	240	N	0.02	D	0.26
Low Level	N,R1-C5	6,447	D	58,800	N,R1-C5	2,588	D	5,618	N,R1-C5	0.70	D	8.49
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level	N,C	1,000	D-R2	1,010	N,C	1,000	D-R2	1,010	All	0.04	All	0.04
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**7,676**		**61,735**		**3,606**		**6,868**		**0.76**		**8.79**

Table 11.19-1. West Valley Demonstration Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All	0.00	All	0.00	All	0.00	All	0.00	R1-C	7	N	26
Low Level	N,R1-C5	0.06	D	0.11	N,R1-C5	0.02	D	0.05	N,R1-C5	330	D	614
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level	N,D	0.00	R1-C	0.01	All	0.00	All	0.00	D-C	29	N	30
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.06**		**0.11**		**0.02**		**0.05**		**366**		**670**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. West Valley has de minimis quantities of transuranic waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.19–2. West Valley Demonstration Project Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population Collective dose, 10 years (person-rem) Number of cancer fatalities from collective dose	(1) (2)	1.10E–01 ~0	2.80E–03 ~0	2.80E–01 ~0	4.44E–03 ~0	9.10E+01 ~0	9.11E+01 ~0	9.14E+01 ~0	9.11E+01 ~0
Offsite Maximum Exposed Individual Annual dose, atmospheric releases (mrem)	(3)	3.00E–04	4.20E–06	4.20E–04	6.62E–06	2.50E+00	2.50E+00	2.50E+00	2.50E+00
Worker Population Collective dose, 10 years (person-rem) Number of cancer fatalities from collective dose	(4) (1)	1.40E–01 ~0	1.52E+02 ~0	3.00E+02 1.20E–01	2.22E+02 ~0	1.50E+03 6.00E–01	1.65E+03 6.61E–01	1.80E+03 7.20E–01	1.72E+03 6.89E–01
Transportation Effects on Offsite Maximum Exposed Individual Number of truck shipments (10 yr) Number of rail shipments (10 yr) Annual dose (mrem) from truck transport Annual dose (mrem) from rail transport	(5)	0 0 0.0E+00 0.0E+00	340 68 1.4E–02 2.7E–03	7,060 2,648 2.5E–02 6.9E–03	6,990 2,578 2.50E–02 6.75E–03	21,000 13,300 8.4E–01 5.3E–01	21,340 13,368 8.5E–01 5.4E–01	28,060 15,948 8.7E–01 5.4E–01	27,990 15,878 8.7E–01 5.4E–01
Resources and Infrastructure Land area (% of available area) Water use (% capacity) Wastewater treatment (% capacity) Power demand (% current load)		25% 64% 100% 45%	2.00% 6.98% 5.15% 11.69%	8.86% 56.12% 9.81% 135.23%	2.11% 7.11% 5.39% 11.85%	0% 0% 0% 61%	27% 71% 105% 117%	34% 120% 110% 241%	27% 71% 105% 117%
Employment Number of site workers	(7)	1,100	123	276	142	1,368	2,591	2,744	2,610
Air Quality Exceedances	(5)	None	None	None	None	None	None	None	None
Groundwater Quality Exceedances	(6)	2 parameters exceeded	None	None	None	None	2 parameters exceeded	2 parameters exceeded	2 parameters exceeded

[a] Includes impacts of HLW vitrification (as identified in DOE, 1982a) and completion and closure of the WVDP (as identified in DOE, 1996f). The alternatives analyzed in the WVDP completion and closure EIS include WVDP waste volumes analyzed in the WM PEIS.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes:
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

WVDP is in an attainment region where criteria air pollutants do not exceed standards. The cumulative emissions are not expected to result in air quality standard exceedances. Disposal is considered at WVDP only under the Decentralized Alternative (not the preferred alternative) for LLMW; no drinking water standards are expected to be exceeded in groundwater for this alternative.

The combined alternatives would affect between 4 and 20 acres of land. This area is about 9% of the total suitable acreage at WVDP and 12% of the area available for waste management facilities. The maximum cumulative demand for wastewater treatment and power are expected to exceed existing capacities and will require expansion or upgrading. The combined waste management alternatives could add up to 276 jobs at WVDP, which would not affect existing offsite community infrastructures and institutions. Completion and closure activities could result in an additional 1,368 jobs at WVDP.

11.20 Transportation

In addition to the combined and cumulative impacts of the alternatives at and in the region of each of the major sites, combined and cumulative impacts could also occur regionally and nationally from the transportation of waste. Tables 11.20–1 and 11.20–2 summarize the range of combined impacts that could occur from the routine transport of waste by truck and rail for the alternatives.

For the combination of alternatives that would involve the fewest shipments of waste, the transport of HLW would have the highest number of shipments and shipment miles, while the transport of HLW and TRUW would result in the highest radiological consequences and risks to transport crew members and the population along transportation routes. For the combination of alternatives that would involve the largest number of shipments, the transport of LLW would result in the highest number of shipments, shipment miles, and radiological consequences and risks to transport crew members and the population along transportation routes.

The transport of waste by truck is expected to result in a combined total of between 12 and 69 fatalities for the shipment of LLMW, LLW, TRUW, HLW, and HW. The majority of these fatalities would result from physical trauma directly related to potential accidents and truck fuel emissions. The transport of LLMW,

Table 11.20-1. Combined Waste Management Alternative Truck Transportation Impacts[a]

Waste Type	Waste Transport Shipments and Mileage										
	Number of Waste Shipments				Millions of Miles of Shipments				Maximum Shipments To or From a Site		
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Site	Shipments
Low-Level Mixed	D	480	R3	10,990	D	0.3	R3	14.9	R3	Nevada Test Site	9,650
Low Level	D	24,420	C4	264,060	D	8.6	C1	563.0	C2	Nevada Test Site	257,270
Transuranic	R2	18,640	D	23,900	R2	34.0	D	42.4	D	Waste Isolation Pilot Plant	23,680
High Level	D	19,912	C	28,224	D	29.4	C	39.5	C	Hanford Site	28,224
Hazardous	R2	1,685	R1	2,483	R2	30.0	R1	55.7	R1	Hanford Site	423
Total		**65,137**		**329,657**		**102.3**		**715.5**			b

Waste Type	Radiological Doses from Waste Transport								Waste Transport Fatalities			
	Routine Occupational Dose in Person-Rem				Routine Population Dose in Person-Rem				Vehicle Emission Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	8.2E+00	R3	4.3E+02	D	4.7E+00	R3	5.1E+02	D	4.6E-03	R3	1.0E-01
Low Level	D	3.2E+02	C1	1.6E+04	D	3.4E+02	C1,5	1.9E+04	D	8.8E-02	C2	2.9E+00
Transuranic	R2	2.9E+03	D	3.7E+03	R2	2.9E+03	D	3.9E+03	R2	1.8E-01	D	2.2E-01
High Level	D	2.6E+03	C	3.5E+03	D	3.5E+03	C	4.7E+03	D	2.1E-01	C	2.7E-01
Hazardous[c]	--	--	--	--	--	--	--	--	D,R2	1.0E-01	R1	1.8E-01
Total		**5.8E+03**		**2.4E+04**		**6.7E+03**		**2.8E+04**		**5.8E-01**		**3.7E+00**

Waste Type	Waste Transport Fatalities—Continued											
	Number of Occupational Radiation Fatalities				Number of Population Radiation Fatalities				Vehicle-Related Accident Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	3.3E-03	R3	1.7E-01	D	5.5E-03	C	2.9E-01	D	1.8E-02	R3	1.0E+00
Low Level	D-R2	1.0E-01	C1	6.3E+00	D	1.7E-01	C1	9.7E+00	D	4.3E-01	C2	3.5E+01
Transuranic	R2	1.2E+00	D	1.5E+00	R2	1.5E+00	D	1.9E+00	R2	2.4E+00	D	3.0E+00
High Level	D	1.0E+00	C	1.4E+00	D	1.8E+00	C	2.3E+00	D-R2	1.8E+00	C	2.3E+00
Hazardous[c]	--	--	--	--	--	--	--	--	D	2.7E-01	R1	5.3E-01
Total		**2.3E+00**		**9.4E+00**		**3.5E+00**		**1.4E+01**		**4.9E+00**		**4.2E+01**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; R = Regionalized Alternative; -- = not applicable, see footnote (c); scientific notation such as 7.7E+00 = 7.7 and 2.3E+02 = 230.

[a] Range of impacts does not include the impacts of the No Action Alternatives for low-level mixed waste, transuranic waste, and high-level waste. Transport impacts listed are those that would occur over a 20-year period except for HLW, which would occur over about 40 years.

[b] No combined total indicated as different sites involved.

[c] Shipments of hazardous waste do not result in external exposure to radiation and latent cancer fatalities from exposure to radiation.

Table 11.20-2. Combined Waste Management Alternative Rail Transportation Impacts[a]

Waste Type	Waste Transport Shipments and Mileage										
	Number of Waste Shipments				Millions of Miles of Shipments				Maximum Shipments To or From a Site		
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Site	Shipments
Low-Level Mixed	D	350	R3	4,540	D	0.2	R3	6.8	R3	Nevada Test Site	3,700
Low Level	D	9,210	C2	96,880	D	3.5	C2	219.0	C2	Nevada Test Site	96,880
Transuranic	R2	9,360	D	12,010	R2	15.8	D	20.3	D	Waste Isolation Pilot Plant	11,970
High Level	D	3,983	C	5,646	D	6.7	C	8.7	C	Hanford Site	5,646
Hazardous[c]	--	--	--	--	--	--	--	--	--	--	--
Total		**22,903**		**119,076**		**26.2**		**254.8**			**b**

Waste Type	Radiological Doses from Waste Transport								Waste Transport Fatalities			
	Routine Occupational Dose in Person-Rem				Routine Population Dose in Person-Rem				Vehicle Emission Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	2.0E+00	R3	4.1E+01	D	5.8E+00	R3	7.6E+01	D	5.7E-03	R3	5.5E-02
Low Level	D	4.1E+01	C1-3,5	1.2E+03	D	1.3E+02	C1,2	2.3E+03	D	1.2E-01	C1,2,4,5	1.8E+00
Transuranic	R2	6.6E+02	D	8.4E+02	R2	8.2E+02	D	1.1E+03	R2,3	8.0E-02	D,R1,C	1.0E-01
High Level	D	1.5E+02	C	2.1E+02	D	1.7E+02	C	2.2E+02	D	4.1E-02	C	5.0E-02
Hazardous[c]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**8.5E+02**		**2.3E+03**		**1.1E+03**		**3.7E+03**		**2.5E-01**		**2.0E+00**

Waste Type	Waste Transport Fatalities—Continued											
	Number of Occupational Radiation Fatalities[d]				Number of Population Radiation Fatalities				Vehicle-Related Accident Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	8.1E-04	R3	1.7E-01	D	3.1E-03	R3	3.8E-02	D	5.0E-04	R3,C	1.4E-02
Low Level	D	1.6E-02	C1,3	4.8E-01	D	6.4E-02	C1,2,4,5	1.2E+00	D	7.3E-03	C1,5	4.7E-01
Transuranic	R2	2.6E-01	D	3.3E-01	R2	4.1E-01	D	5.7E-01	R2	3.3E-02	D	4.3E-02
High Level	D	6.1E-02	C	8.2E-02	D	8.4E-02	C	1.1E-01	D	1.4E-02	C	1.8E-02
Hazardous[c]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.4E-01**		**1.1E+00**		**5.6E-01**		**1.9E+00**		**5.5E-02**		**5.5E-01**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; R = Regionalized Alternative; -- = not applicable, see footnote (c); scientific notation such as 7.7E+00 = 7.7 and 2.3E+02 = 230.

[a] Range of impacts does not include the impacts of the No Action Alternatives for low-level mixed waste, transuranic waste, and high-level waste. Transport impacts listed are those that would occur over a 20-year period except for HLW, which would occur over about 40 years.

[b] No combined total indicated as different sites involved.

[c] All shipments of hazardous waste were analyzed on the basis of transport by truck.

[d] Rail crew values are expected to range from impacts listed in this table (for dedicated shipments) to slightly higher than the truck crew impacts identified in the previous table. See Section 5.4.1.1 for a more detailed explanation.

LLW, TRUW, and HLW by rail would result in approximately the same number of fatalities from radiological causes as from vehicle-related causes. HW transportation by truck does not contribute to the potential radiological fatalities but does contribute to physical trauma fatalities. A major difference between truck and rail transport is the number of potential fatalities from physical trauma. All truck transport could potentially result in 5 to 42 physical trauma fatalities, while all rail transport could potentially result in up to one physical trauma fatality. These fatalities from physical trauma for both truck and rail accidents are independent of the shipment contents. Comparatively, from 1971 through 1993, over one million persons were killed in vehicular accidents in the United States (DOE, 1995d). A discussion of the uncertainties involved when comparing the truck and rail transportation impacts is presented in Appendix E, Section E.8.5.

The largest number of shipments to or from a single site could occur at the Nevada Test Site as a result of shipments LLMW and LLW, and the shipments of HLW if Yucca Mountain is found to be suitable for the emplacement of defense HLW. A combined total of more than 295,000 truck shipments or more than 106,000 rail shipments of waste could occur at the Nevada Test Site, or about 118 truck shipments or 42 rail shipments per day (assuming receipt of shipments during 250 days per year).

The transport of each of the waste types under the alternatives is only one source of potential risk associated with the shipment of radioactive materials. Other sources of risk include the shipments of DOE and commercial spent nuclear fuel, other DOE nuclear materials, radioisotopes used in medicine and other activities, and commercial waste. Table 11.20–3 summarizes existing and reasonably foreseeable shipments of radioactive materials that have been included in the assessment of cumulative transportation impacts but that are not a part of the alternatives. A discussion of these other shipments is contained in DOE (1995d).

Table 11.20–4 summarizes the potential cumulative transportation-related radiological collective doses and latent cancer fatalities. Over the 93-year period from 1943 through about 2035, the total number of radiation-related cancer fatalities is estimated at 315, or about three latent cancer fatalities per year on average. Cumulatively, the non-DOE transport of radioactive material accounts for approximately 80% of the collective dose to workers and the public and therefore radiation-related latent cancer fatalities. The total number of potential radiation-related latent cancer fatalities associated with the alternatives in this WM PEIS are about 7% of the cumulative radiation-related latent cancer fatalities.

Table 11.20-3. Other Activities Considered in the Cumulative Transportation Assessment

Activity	Description
Existing activities	
Historical spent nuclear fuel	Historical shipments of DOE spent nuclear fuel to Hanford Site, Idaho National Engineering Laboratory, Savannah River Site, Oak Ridge Reservation, and Nevada Test Site
General transportation	Nationwide transport of radioactive materials for medical, industrial, fuel cycle, and disposal purposes
Reasonably foreseeable activities	
Interim spent nuclear fuel Management	Shipments to and between locations for the storage and interim management of DOE spent nuclear fuel
Geologic repository	Shipments of commercial spent nuclear fuel to the candidate geologic repository at Yucca Mountain, Nevada[a]
Naval reactor components	Shipments of reactor compartments from Puget Sound Naval Shipyard to Hanford
Return of isotope capsules	Shipments of cesium-137 isotope capsules to the Hanford Site
Uranium billets	Shipment of low-enriched uranium billets from the Hanford Site to the United Kingdom

[a] Transportation of TRUW to WIPP is incorporated in the waste management alternatives presented in Section 11.18.

Table 11.20-4. Cumulative Transportation-Related Radiological Collective Doses and Latent Cancer Fatalities[a]

Category	Collective Occupational Dose in Person-Rem	Collective General Population Dose in Person-Rem
Historical DOE spent nuclear fuel shipments (1943-1993)	265.4	106.3
Interim management of DOE spent nuclear fuel shipments		
Naval (truck and train)	1.5 to 15	0.34 to 12
DOE (100% truck 1995 to 2035)	0.0 to 1,000	0.0 to 2,300
DOE (100% train 1995 to 2035)	0.0 to 130	0.0 to 170
Reasonably foreseeable shipments		
Commercial spent nuclear fuel and defense high-level waste to geologic repository[b]	8,600	48,000
Submarine reactor component disposal	--	0.053
Return of cesium-137 isotope capsules	0.42	5.7
Uranium billets	0.50	0.014
Non-DOE shipments of radioactive materials		
1943 to 1982	220,000	170,000
1983 to 2035	89,000	98,000
Waste management alternatives		
Low-level mixed waste	7.7 to 430	9.2 to 510
Low-level waste	230 to 16,000	240 to 19,000
Transuranic waste[c]	2,900 to 3,700	2,900 to 3,900
High-level waste[b]	3,200 to 3,500	4,300 to 4,800
Hazardous waste	--	--
Total collective dose	342,510	346,630
Total latent cancer fatalities	140	175

[a] Estimated occupational and general population doses for all categories except waste management alternatives are based on DOE (1995d).
[b] Shipments to geologic repository and HLW alternatives both include the shipment of HLW from DOE sites to the candidate geologic repository at Yucca Mountain.
[c] TRUW alternatives include the shipment of TRUW to the Waste Isolation Pilot Plant.

Chapter 11
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CHAPTER 12
Mitigation Measures and Unavoidable Adverse Impacts and Irreversible and Irretrievable Commitments of Resources

This chapter discusses possible programmatic and other mitigation measures that could be implemented to reduce or eliminate some adverse environmental impacts. The chapter also addresses unavoidable adverse impacts, the relationship between short-term uses of the environment and the maintenance of long-term productivity, and any irreversible and irretrievable commitments of resources that would occur because of waste management activities.

The regulations promulgated by the Council on Environmental Quality to implement the procedural provisions of the National Environmental Policy Act (42 USC 4321 *et seq.*) (NEPA) require that an environmental impact statement (EIS) include a discussion of appropriate mitigation measures (see 40 CFR 1502.14(f); 40 CFR 1502.16(h)). The term "mitigation" includes the following:

- Avoiding an impact by not taking an action
- Minimizing impacts by limiting the degree or magnitude of an action
- Rectifying an impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time
- Compensating for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20)

In addition, NEPA mandates that an EIS address any adverse environmental effects that cannot be avoided should the proposal be implemented, the relationship between short-term uses of the environment and maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented (NEPA, 102(2)(C)). This chapter describes possible mitigation measures, unavoidable impacts, and irreversible and irretrievable commitments of resources that could result from waste management activities.

12.1 Programmatic Mitigation Measures

The potential human health risks, environmental impacts, and costs associated with the waste management alternatives could be reduced or mitigated through the implementation of programmatic and other mitigation measures. Such programmatic measures to reduce or eliminate potential risks, impacts, and costs are described below. Other mitigation measures are described in Section 12.2.

Pollution Prevention: DOE has a pollution prevention policy that requires DOE sites to employ pollution prevention strategies. To implement these requirements, DOE issued the *1994 Waste Minimization/Pollution Prevention Crosscut Plan* (DOE, 1994) that establishes a DOE-wide goal to meet pollution reduction targets (Executive Order 12856): a 50% reduction in total releases and offsite shipments of toxic chemicals and pollutants by December 31, 1999. The 1994 Crosscut Plan calls for each DOE site to establish site-specific reduction goals for hazardous, radioactive, radioactive mixed, and sanitary wastes and pollutants. Currently, site-specific goals are being prepared. Future implementation of pollution prevention may result in the reduction of future quantities of wastes that require storage, treatment, and disposal, thereby reducing the impacts associated with the construction and operation of these facilities.

Implementing Waste Acceptance Criteria and/or Performance Assessments at low-level mixed waste (LLMW) and low-level waste (LLW) disposal sites: Under DOE Order 5820.2a (DOE, 1988), DOE sites must establish performance objectives for the management of LLW to protect human health and the environment. Each site is responsible to implement and maintain performance assessment documentation. Waste Acceptance Criteria for LLW are imposed to ensure that the dose limitations are not exceeded. The Waste Management Programmatic Environmental Impact Statement (WM PEIS) did not factor the LLW Waste Acceptance Criteria into the analysis, but rather made the general assumption that all waste slated to be transported to a particular site could be accepted by the receiving site. In reality, this may not be the case. Application of LLW Waste Acceptance Criteria could potentially reduce estimated risk and impacts at a given site. It is anticipated that appropriate LLMW Waste Acceptance Criteria will be developed.

Selecting treatment and disposal facility locations within the fenceline based upon site-specific geology and demographics: The analysis required that a specific location be identified to conduct the human health risk and air quality and ecological impact assessments at each site. DOE chose the location of existing facilities to conduct these analyses; however, when no facilities existed onsite, a central location was selected for the placement of the waste management facility. The estimates of human health risk and air quality and ecological impacts may be reduced or mitigated if alternative locations are selected based on site-specific data and considerations. The potential for natural hazards such as floods, erosion, tornadoes, earthquakes, and volcanoes will be considered in selecting the exact locations of facilities.

Changing treatment and disposal technologies based upon site-specific waste criteria, or applying emerging technologies not considered during this study: A base technology was selected for all alternatives. The various processes, identified in the process flow diagrams, reflect only currently existing, proven technologies. They are also generic in the sense that the same technologies have been applied at all sites. Risk and impacts may be reduced or mitigated in the future by applying technologies that may not have been developed prior to this study, or by implementing tailored technologies based on site-specific and waste-specific needs.

Modifying the engineering facility design to reduce or eliminate risk or impacts: For consistency, the design parameters for each treatment process were the same, regardless of the site or specific waste characteristics (although alpha and remote-handled wastes were treated in engineered facilities designed specifically to meet their special treatment and handling needs). The generic models were developed to meet DOE's General Design Criteria. However, the actual design would be refined to reflect unique, site-specific environmental parameters and operational parameters (e.g., differences in waste loads, chemical and radionuclide composition, and facility age). Tailored designs could reduce anticipated impacts.

Transporting waste based on treatment need rather than geographic proximity, similar to and in close coordination with arrangements specified in the Federal Facility Compliance Act (FFCAct) Site Treatment Plans (STPs): Geographic proximity was used to assign shipping routes for LLMW between DOE sites. This assumption eliminated subjective judgments on where to ship and handle waste and minimized transportation miles. However, the FFCAct (42 USC 6961 *et seq.*) site treatment plan process has established site-specific treatment and shipping arrangements in which DOE's LLMW is transported based upon mutual agreement by the shipping and receiving sites. In addition, the STPs usually consolidate waste for treatment based upon treatment needs of specific waste streams, rather than on geographic proximity. This would reduce total construction requirements and result in fewer impacts and costs at the sites, although impacts from transporting waste between sites may increase.

Using a mix of truck and rail transport based on shipment location, size, and availability: Both truck and rail transport of wastes were analyzed on a DOE-wide basis. However, a more appropriate mix of truck and rail could be chosen to minimize potential risk and impacts at both the receiving and shipping locations, and along the transportation route. Selection of transportation means will be based on human health risks, environmental impacts, and costs.

Combining facilities for various waste types and waste streams, such as the collocation of LLW and LLMW treatment: Although the DOE analyzed the risks, impacts, and costs associated with facilities dedicated to a specific waste type, combining facilities to take advantage of similar processing technologies and units, infrastructure requirements, and skilled labor could reduce adverse impacts. Combining or locating more than one treatment facility at a site may reduce the risks, impacts, and costs associated with the construction of multiple, new facilities across DOE sites.

Adjusting timing and scheduling of both the analytical time frame of 20 years and the construction and work-off periods for all waste types except HLW: DOE used uniform assumptions for scheduling the construction and treatment periods for inventoried and annually generated wastes (called work-off periods) for all waste types except HLW. This assumption was required to compare impacts and waste loads for a given time period. However, adjustment of the timing and work-off schedules could result in reduced risk and impacts. For example for LLW, LLMW, TRUW and HW under all alternatives except No Action, all facilities were sized according to an averaged throughput over a 10-year period, after assuming a 10-year construction period when wastes were accumulated in a storage facility awaiting treatment. If, however, construction could be completed in a shorter time frame, less waste would accumulate, providing the opportunity for a decreased annual throughput. Additionally, if the work-off period were longer (e.g., 20 years, as opposed to 10), the annual throughput and emissions rates would be reduced.

Implementing strict and mandatory safety programs for all facility and transportation workers: Most of the worker risk associated with treatment and transportation of waste results from industrial type accidents, which were based on actual industrial accident and transportation statistics. The implementation of an intensive and comprehensive training program has reduced the industrial accidents experienced at DOE facilities, resulting in less risk and a more highly skilled, experienced workforce.

Providing retraining opportunities for experienced, skilled DOE workers to move between facilities and jobs within DOE: Good training and experienced workers will likely result in fewer work-related injuries. The WM PEIS assumes the in-migration of workers for each new treatment and disposal facility; however, arrangements might be made to utilize special teams of experienced DOE workers thereby creating a dedicated workforce, redistributing and optimizing employment demands at any given location and potentially reducing risk caused by inexperience.

Future Technology Development: The waste management technologies analyzed in the WM PEIS are those technologies that have been approved by regulators. Other, emerging technologies, however, have not been widely accepted by regulators or are not yet demonstrated and available. Such technologies, while believed to be sound in theory, may require significant development prior to becoming proven, demonstrated, and acceptable to regulators.

Technology is a major factor in DOE's waste management decisions. The availability, or the projected availability, of appropriate technologies will govern what can be effectively managed with the least risk to health, safety, and the environment. While the selection of technologies is most appropriate to project-specific implementation decisions, technology selection could mitigate the environmental impacts and the economic costs of future waste management activities.

DOE manages an aggressive national program of applied research, development, demonstration, testing, and evaluation for environmental cleanup, waste management, and related technologies. The primary objective of this effort is to achieve compliance with applicable regulations, while lowering human health risks, environmental impacts, and costs. In many cases, the development of new technology presents a greater hope for ensuring a substantial reduction in risk to the environment and improved worker and public safety within realistic financial constraints. DOE is currently pursuing three emerging technologies that could mitigate the potential impacts and costs of implementing the alternatives. These technologies are: treatment of organic contaminants (e.g., nonthermal destruction), monitoring of emissions from treatment (e.g., real-time, continuous emission monitoring), and current transportation development activities (e.g., hazardous materials packagings).

12.2 Other Mitigation Measures

Potential mitigation measures that DOE could implement to reduce human health risks and environmental impacts at each site are summarized in Table 12–1. These measures may be considered in greater detail in sitewide or project-specific NEPA reviews conducted prior to decisions to construct waste management facilities at particular locations at DOE sites. The extent to which risks and impacts may be reduced or eliminated depends on conditions at individual DOE sites.

12.3 Unavoidable Adverse Environmental Effects

Regardless of the alternatives selected by DOE, and despite implementation of the mitigation measures described above, there would be some adverse environmental impacts caused by treating, storing,

Table 12-1. Potential Mitigation Measures

Impact Area	Mitigation Measures
Air Quality—Construction	
Fugitive Dust	• Use of water or chemicals for dust control during road grading or site clearing • Application of asphalt, water, grass seed, or suitable chemical treatments on dirt roads, fill stockpiles, and other surfaces that can give rise to airborne dust • Covering of open bed trucks
Equipment Exhaust	• No unnecessary idling of equipment
Air Quality—Operation	
Thermal Treatment Unit (Incinerator)	• Implementing a potentially cleaner alternative organic treatment technology • Changing incinerator design (e.g., using additional filters to remove particulates, building taller stack to provide greater dispersion, using higher operating temperature to attain more complete destruction of organic contaminants) • Changing composition of waste incinerated (e.g., change waste acceptance criteria to limit amount of certain materials in waste such as radionuclides) • Selecting cleaner burning fuels (e.g., natural gas and low sulfur fuel oils) • Limiting rate of waste introduced into the incinerator (known as the charging rate) • Compensating emissions from new facilities with reduced emissions from existing facilities
Transportation	• Implementing transportation control programs that reduce work-related and vehicle miles traveled such as: ▸ Ridesharing, transit programs, parking management, compressed work weeks, flextime, telecommuting
Water Resources—Construction	
Availability	• Reducing amount of water used for dust suppression and design changes to reduce concrete requirements • Use of alternate water source to minimize impacts to onsite water resources such as alternatives to water for use in dust suppression and concrete mixing or mixing concrete offsite and transporting to the site in mixing trucks
Water Resources—Operation	
Availability	• Changing engineering design to increase recycle and reuse of water within facility such as zero discharge facility design • Switching surface water use to groundwater or municipal water supply and vice versa depending upon which resource is more limited • Returning water to source if adequate quality is maintained • Compensating water use requirements for new facilities with reduced water use from existing facilities
Water Resources—Disposal	
Groundwater Quality	• Limiting disposal of problem isotopes or storing waste containing problem isotopes until radioactive decay lessened their concentration • Changing waste form (e.g., vitrification or encasement of waste in polymer resin) • Changing disposal facility design to provide greater isolation (e.g., change shallow land burial to greater confinement disposal) • Increase the institutional control period and the environmental monitoring period to reduce the chance of an undetected release

Table 12-1. Potential Mitigation Measures—Continued

Impact Area	Mitigation Measures
Ecological Resources Habitat	• Minimize land area requirements and maintain flexible site design and facility placement to help avoid sensitive habitats • Use engineering control practices during construction to minimize direct discharges to aquatic resource habitats • Consider use of native species for mitigation and/or restoration of habitat impacts • Compensate wetland loss or other habitat loss with creation of new habitat
Economic and Population	• Maintain consistent level of funding throughout the life of the project to provide stable economic environment • Assist community to compensate for situations where existing resources may fall short of demand (e.g., return of land suitable for development to local community) • Close coordination with appropriate agencies (public and private) in local community to anticipate future demand and plan necessary facilities • Staggering start and shut-down dates to extend the period over which the complex employs waste management workers • Job training and retraining (to help reduce demand for new employees who would in-migrate into regions and place additional demands on local infrastructure) • Cooperation and communication with existing industries to identify and take advantage of opportunities for diversification
Infrastructure	• Expansion of water supply, wastewater treatment, and power supply capacity or allotment to meet new demand and anticipated long term regional growth; consideration of burden payments may be necessary, depending upon severity of impacts • Implementation of or strengthening of site resource conservation measures (e.g., reducing landscaping irrigation, using reclaimed greywater for irrigation and other uses where possible, installing energy-efficient fluorescent lights) • Implementation of or strengthening of community resource conservation measures and education (e.g., rating homes and businesses for energy-efficiency and providing incentives for improvements) • Working with local and regional planners to prepare for additional road traffic, water, wastewater treatment, and power supply requirements to enhance ability of affected jurisdictions to plan effectively
	• Compensate infrastructure requirements for new facilities with reduced infrastructure requirements from existing facilities
Cultural Resources	• Use of surveys to ensure adherence with the National Historic Preservation Act and associated regulations • Involvement of stakeholders concerned about cultural resources in decision making

Table 12-1. Potential Mitigation Measures—Continued

Impact Area	Mitigation Measures
Public and Worker Safety	• Use of safety analyses to establish safety limits within which a facility can operate while limiting risks and adequately protecting the environment • Review and modification, as appropriate, of existing emergency action plans at DOE sites to ensure appropriate response to accidents and other emergencies that might arise from operation of new waste management facilities • Planning of specific transportation routes to minimize risk using DOT routing guidelines • Training to ensure that emergency response personnel are knowledgeable of emergency response procedures

disposing, and transporting wastes. The location and severity of these impacts will depend on which of the alternatives is implemented for a given waste type. In general, more sites will experience unavoidable impacts under the Decentralized Alternative for any of the waste types than under the Regionalized or Centralized alternatives. Aggregate transportation impacts, in contrast, will increase under the Regionalized and Centralized alternatives because more shipments would be required to treat and dispose the total aggregate waste load. This section includes discussion of adverse effects that potential mitigation measures could not reduce or avoid.

Health Risk to Workers and the Public. Some health risks to workers and the public will be unavoidable at the time selected management strategies are implemented. Workers at facility construction sites, operating waste management facilities, and involved in truck or rail shipments are subject to the same types and frequencies of injuries and accidental deaths that workers experience across the industrial sector of the nation. Workers would also be exposed to the specific health risks of exposures to radiation and hazardous chemicals. The public would generally be at a lower risk than any of the workers involved in waste management activities. Risks would be higher at those sites where waste management activities are concentrated; where the largest waste loads are treated and disposed of under the Regionalized and Centralized alternatives. The Decentralized alternatives would tend to spread the public health risks more evenly across the sites. Although more individuals are likely to be at risk, their exposure levels are likely to be lower. Transportation risks too would tend to be lower under the Decentralized alternatives because the bulk of the wastes would remain at their site of origin.

Air Quality. Construction activities at each site would result in short term, elevated levels of particulate matter in localized areas. During the operational phases of facilities, air quality would be affected unavoidably through the introduction of criteria and hazardous and toxic air pollutant emissions at the sites and from worker vehicles and truck or rail waste shipment vehicles. In general, these impacts would be greater under those alternatives where activities are concentrated at a single site (Centralized) or group of sites (Regionalized). Criteria air pollutants in particular would increase where worker vehicle traffic, waste shipments by truck or rail, and fuel burning by waste management facilities all are at their highest levels at the Centralized sites. Effects at any single site would reflect the specific attainment status of the site's air quality control region for each criteria air pollutant. These effects would increase if one site is chosen as the Centralized location for management of two or more waste types.

Habitats. Portions of nonsensitive terrestrial habitats would be lost when waste management facilities are constructed. A greater amount of habitat acreage will be lost in aggregate under the Decentralized Alternative because each site must build facilities to manage its own wastes. At any single site, however, the greatest habitat loss would be in the Centralized Alternative where facilities to treat and dispose of all the waste of a particular type would be built at one site. Based on the WM PEIS analyses, none of these habitat losses is expected to constitute a significant impact to the resident plant and animal species because these species have broad ranges and the amount of lost habitat would comprise only a small fraction of these communities. Impacts to sensitive species and their habitats may be avoidable because decisions on specific facility locations at a site are yet to be made.

Economic Effects. The economic effects of the waste management alternatives would generally be considered beneficial, adding jobs and infusing monies to the regional economy at each site. The major sites would benefit more under the Centralized alternatives. However, at those sites where waste may be shipped offsite for treatment or disposal, there could be economic impacts, due to the relocation of jobs or reduced expenditures in the region of influence. These effects are partially offset by the increased potential for economic diversification that may result from alternate economic uses of the land.

Infrastructure Impacts. Infrastructure impacts are unavoidable at sites where existing systems are currently nearing capacity. At sites where DOE's decisions to implement waste management activities require construction of additional water supply, electrical power supply, waste water treatment, or transportation infrastructure, the environmental impacts of such construction projects would be unavoidable. Also, use of energy and water resources to support operation would be unavoidable.

Cultural Resource Impacts. In most instances, project requirements for available land at sites are sufficiently small to allow DOE to avoid impacts to cultural resources. As was the case with sensitive species and environmental justice concerns, decisions on specific facility locations are yet to be made. However, the cultural resource surveys and impacts analysis that would be part of the NEPA reviews at the site and project level should provide sufficient data to enable DOE to site required facilities with minimal or no effect on existing cultural resources.

12.4 Relationship Between Short-Term Use of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Short-term impacts are those that would occur during waste management facility construction and operation. Impacts that extend beyond the period of waste management facility operations are considered to be long-term.

The implementation of each of the waste management alternatives would require short-term use of the environment and a variety of resources such as land, fuel, construction materials, and labor. Development of new waste management treatment and storage facilities would commit lands to those uses from the beginning of the construction period through the duration of the operation period and until such facility is fully decommissioned. Depending upon the specific locations at sites selected for treatment and storage facilities, some terrestrial habitat may be lost when the area is cleared for construction. Disturbance of this acreage would eliminate the natural productivity of the land. At the end of the operational period, these waste management facilities could be converted to other industrial uses or decontaminated and decommissioned and the land returned to its original use or a condition compatible with future uses.

Since certain DOE wastes contain long-lived radionuclides, disposal actions are expected to commit resources for an indefinite period of time, resulting in the potential long-term loss of resources and productivity. The loss of land for disposal may be especially important at sites with small land areas. Proper disposal of wastes, however, has the benefit or providing long-term isolation of wastes from the environment while not incurring the use of additional land areas, costs, and labor resources for indefinite storage of wastes.

Wetlands, threatened or endangered species habitats, wildlife preserves, parklands, rare habitats, and other specially designated sites are considered to be ecologically sensitive areas. The analysis of ecological resource impacts assumes that significant impacts to ecologically sensitive areas as a result of new treatment, storage and disposal facility construction can generally be avoided because DOE will have flexibility in locating waste management facilities at particular sites.

Ecological resources would be affected mainly through disturbance or loss of habitat resulting from site clearing and construction. Terrestrial resources would be directly affected by land clearing, which would adversely affect the habitat of terrestrial animals. These changes may be significant for individual animals of certain species with limited home ranges, such as small mammals and songbirds, and lead to direct mortality and higher susceptibility to predation. Given the amount of land area required for waste management facilities and the expected availability of locally similar habitat, the overall effect should be displacement of individual organisms with limited impact on local populations.

Aquatic resources may be indirectly affected through increased runoff and sedimentation in surface waters from disturbed land areas. However, the use of various mitigation techniques could minimize potential waste management facility construction impacts to aquatic ecological resources. Direct discharges of contaminants to surface waters from the routine operation of waste management facilities are expected to be limited by engineering control practices. Therefore, long-term impacts to aquatic organisms are expected to be minimal.

12.5 Irreversible and Irretrievable Commitments of Resources

This section describes the major irreversible and irretrievable commitments of resources that can be identified at this programmatic level of analysis. A commitment of resources is irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for future use.

The programmatic decisions resulting from this PEIS will select waste management strategies that could lead to the commitment of resources to new construction and renovation of treatment, storage, and disposal facilities at identified sites. This section discusses three major resource categories that could be committed irreversibly or irretrievably to the proposed action at the time strategy is implemented: land, materials, and energy.

Land Use. The land that is currently occupied by treatment and storage facilities could ultimately be returned to open space uses if buildings, roads, and other structures were removed, areas cleaned up, and the land revegetated. Alternatively, the facilities could be modified for use in other DOE programs. Therefore, the commitment of such land is not necessarily irreversible.

However, land rendered unfit for other purposes, such as that set aside for disposal facilities, represents an irreversible commitment of resources. The land could not be restored to its original condition, nor could the site feasibly be used for any other purposes following closure of the disposal facility. This land would be perpetually unusable because it would not be available for other potential intrusive uses such as mining, utilities, or foundations for other buildings.

The value of any land set aside for waste management operations, whether calculated in market terms or as the value of other social or economic land uses that may be forgone, is a site-specific consideration. Because the actual locations of WM facilities on sites will not be determined by this PEIS, it is not possible to discuss the potential for lost value of any land designated for WM use nor the potential change in value of any adjacent land. These will be more appropriately addressed in tiered, sitewide or project-specific NEPA analyses where the importance of specific land areas and uses to stakeholder groups in the region can be considered.

In the environmental impact statement for FEMP, for instance, it was stated that DOE expected to irreversibly commit some 220 acres of the approximately 1,000-acre site for long-term disposal. Under current law, such commitments documented in an environmental impact statement or comparable environment analysis are immunized from natural resource damage liability. Similar commitments could occur in siting facilities based on decisions that result from this PEIS. In addition, DOE will attempt to identify sensitive resources prior to siting in order to minimize the impact that long-term disposal may have on natural resources of value to humans and the environment.

Material. The irreversible and irretrievable commitment of material resources during the life-cycle of treatment, storage, and disposal facilities includes construction materials that cannot be recovered or recycled, materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Where construction is necessary, materials required include wood, concrete, sand, gravel, plastics, steel, aluminum, and other metals. These construction resources, except for those that can be recovered and recycled with present technology, would be irretrievably lost.

However, none of those identified construction resources is in short supply, and all are readily available in the vicinity of locations being considered for new waste management facilities.

The commitment of materials in new equipment that cannot be recycled at the end of the project's useful lifetime is irretrievable. Consumption of operating supplies, chemicals, and gases, while irretrievable, is not expected to involve any material in critically short supply in the United States.

Materials reduced to unrecoverable forms of waste, such as uranium, are also irretrievably lost. However, strategic and critical materials, or resources having small natural reserves, are of such value that economics promotes recycling. Plans to recover and recycle as much of these valuable, depletable resources as is practical depend on need, and each item would be considered individually at the time a recovery decision is required.

Energy. The irretrievable commitment of resources during construction and operations of facilities would include the consumption of fossil fuels used to generate heat and electricity. Energy would also be expended in the form of diesel fuel, gasoline, and oil for construction equipment and transportation vehicles. The amount of energy required to operate treatment, storage and disposal facilities, and construction equipment and transportation vehicles would be irretrievable.

Chapter 12
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CHAPTER 13
List of Preparers

Those who filled primary roles in the preparation of this Department of Energy (DOE) Waste Management Programmatic Environmental Impact Statement (WM PEIS) are noted in this chapter.

The WM PEIS project manager is David Hoel of DOE's Office of Environmental Management.

For preparation of the WM PEIS, primary assistance was provided to DOE by Argonne National Laboratory (ANL), and its subcontractors, Maria Elena Toraño Associates, Inc. (META), Louis Berger and Associates, Inc. (Berger), Lamb Associates, Inc. (Lamb) and Brown and Root Environmental (BRE). The DOE WM PEIS Team provided direction to the WM PEIS contractors through ANL. ANL and its subcontractors were responsible for developing analytical methodology and alternatives, and for work coordination, impact analysis, and production of the WM PEIS. DOE was responsible for data quality, for the scope and content of the WM PEIS, and for providing issue resolution and direction to ANL and its subcontractors.

Several of the national laboratories assisted in preparing supporting information and documentation. These included Argonne National Laboratory-East (ANL); Oak Ridge National Laboratory (ORNL); Battelle Pacific Northwest National Laboratory (PNNL); Los Alamos National Laboratory (LANL); and Idaho National Engineering Laboratory (INEL). These laboratories worked closely throughout the WM PEIS development process. Their interrelationships and contributions are illustrated in Figure 13-1. The supporting information and documentation prepared by the national laboratories were evaluated by DOE. The DOE was responsible for determining the appropriateness and adequacy of incorporating into the WM PEIS any data, analyses, and results of other work performed by the national laboratories before incorporating the information into this PEIS.

Argonne National Laboratory was responsible for integrating the effort of all required contractors and national laboratories, and was the primary responsible organization for producing the Final WM PEIS for DOE.

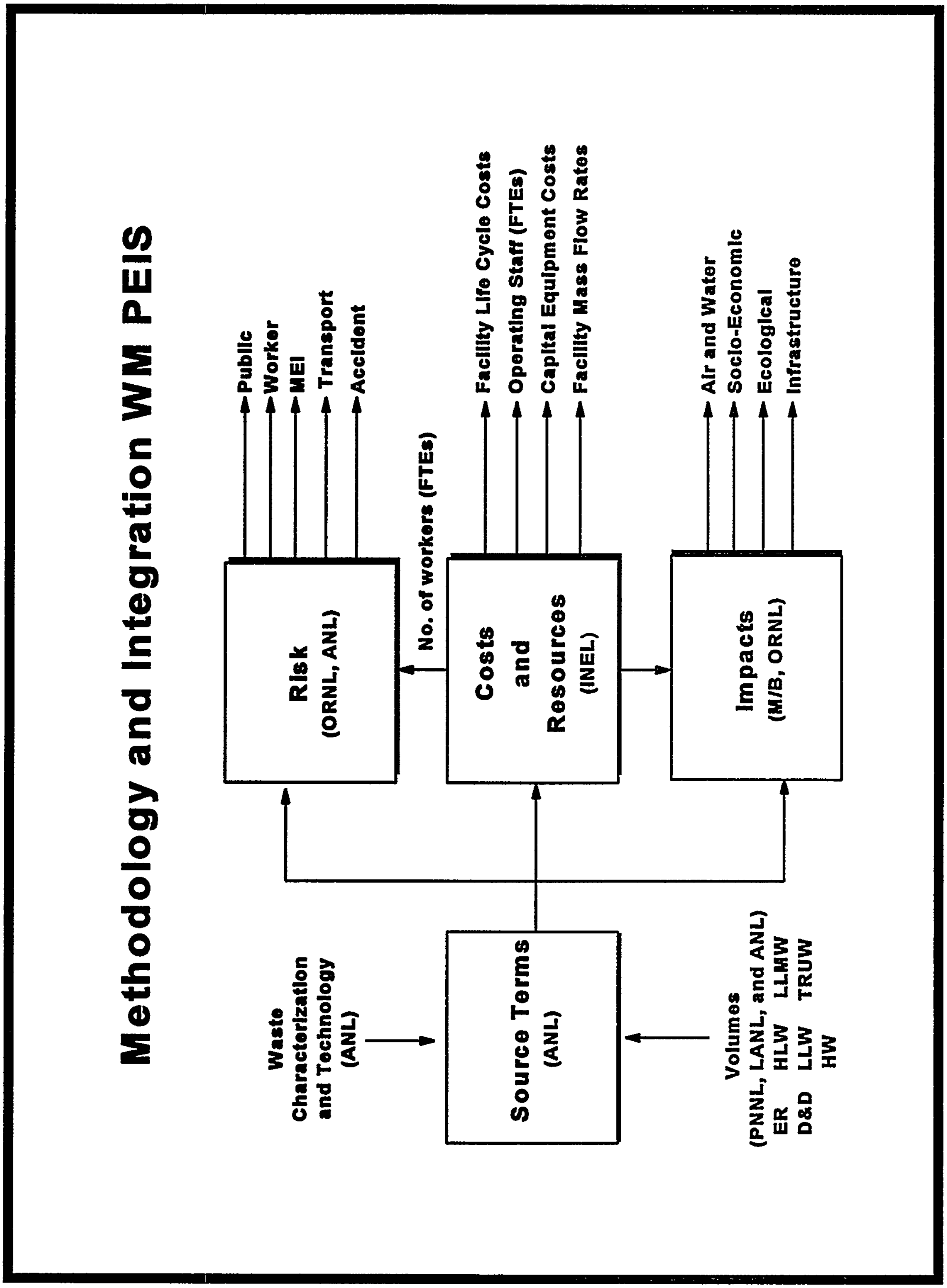

Figure 13-1. WM PEIS Analytical Relationships

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CHAPTER 14
Glossary

100-Year Flood. A flood event of such magnitude it occurs, on average, every 100 years (equates to a 1% probability of occurring in any given year).

500-Year Flood. A flood event of such magnitude it occurs, on average, every 500 years (equates to a 0.2% probability of occurring in any given year).

Absorbed Dose. The energy imparted to matter (such as tissue) by ionizing radiation per unit mass or irradiated material at the place of interest in that material (such as a specific internal organ). The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

Accident, Transportation. In a mobile environment, the harmful effects of an unplanned event on the human environment with respect to both safety and health.

Accident, Treatment, Storage and Disposal [TSD] Facility. Within a stationary environment, the harmful effects of an unplanned event on the human environment (effects on buildings and equipment are relevant only to the degree that human safety and/or health are affected). TSD facility accidents are concerned with safety and health effects arising from both radiological and hazardous sources (contamination, inhalation, or radiation) and from physical phenomena (fire, flood, earthquake, or other mechanical or thermal forces).

Adsorption. The adhesion of a substance to the surface of a solid or solid particles.

Affected Environment. As used in the preparation of an Environmental Impact Statement (EIS), a description of the existing environment (e.g., site descriptions) covering information that directly relates to the scope of the proposed actions and alternatives whose impacts are to be analyzed; i.e., the information necessary to assess or understand the impacts. Often referred to as the baseline for the EIS concerned. Must be in sufficient detail to support the impact analysis including cumulative impact analysis (see "Cumulative Impact"). This information must highlight "environmentally sensitive resources," if present. These include floodplains and wetlands, threatened and endangered species, prime and unique agricultural lands, and property of historic, archaeological, or architectural significance.

Air Pollutant. Any substance, including but not limited to dust fume, gas, mist, odor, smoke, vapor, pollen, soot, carbon, or particulate matter, that is regulated.

Air Quality. The specific measurement in the ambient air of a particular air pollutant at any given time.

Air Quality Control Region (AQCR). An interstate or intrastate area designated by the U.S. Environmental Protection Agency for the attainment and maintenance of National Ambient Air Quality Standards.

Air Quality Criteria. The varying amounts of pollution and lengths of exposure at which specific adverse effects to health and welfare take place.

ALARA. *See* **As Low as Reasonably Achievable.**

Alluvia/Alluvium. Material deposited by running water, such as clay, silt, sand, and gravel.

Alpha-Low-Level Waste. This waste is not a different waste type per se, but rather, low-level radioactive waste materials contaminated with alpha-emitting (helium nuclei) radionuclides not listed under uranium/thorium or low levels (< 100 nanocuries per gram) of transuranic isotopes. Special handling and additional levels of containment are required to protect workers from ingesting this waste into the respiratory system. It is normally disposed similar to low-level waste, except for the precautionary measures for the workers involved (see "Radiation, Alpha Particle").

Alpha Particle. A positively charged subatomic particle emitted from a nucleus during radioactive decay. It is made up of two neutrons and two protons bound together, and hence is identical with the nucleus of a helium atom. It is the least penetrating of the three common types of radiation emitted by radioactive material, and can be stopped by a sheet of paper. It is not dangerous to plants, animals, or humans unless the emitting substance has entered the body.

Alternative. As used in the preparation of an Environmental Impact Statement (EIS), one of the range of reasonable alternatives to the proposed action (see "Action"). For a Programmatic EIS, one of the range of reasonable alternatives for achieving the program's goal or meeting a legislative requirement (i.e., a specific proposed action (project) is not necessarily specified). Reasonable alternatives are those that are practical or feasible from a common sense, technical, *and* economic standpoint.

Alternative, No Action. The No Action Alternative must be considered in a U.S. Department of Energy Environmental Impact Statement. It need not be a reasonable alternative. "No Action" can mean doing nothing or it can mean continuing with an existing course of action. It also can mean discontinuing the present course of action by phasing out operations in the near term. The No Action Alternative is meant to provide an environmental baseline against which impacts of the proposed action (and its alternatives) can be compared (see "Affected Environment").

Alternative, Preferred. The alternative that the U.S. Department of Energy believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors.

Alternatives, Centralized. Alternatives that would result in transporting wastes to one or two sites for treatment, storage, or disposal. As with the Regionalized Alternatives, those sites that have the largest volumes of a given waste type were generally considered as sites for Centralized treatment, storage, or disposal.

Alternatives, Decentralized. Alternatives that would result in managing waste where it is or where it will be generated, treated, or disposed of in the future. Unlike the No Action Alternative, the Decentralized Alternatives may require the siting, construction, and operation of new facilities or the modification of existing facilities. Under the Decentralized Alternatives, the waste management facilities would be located at a larger number of sites than under the Regionalized or Centralized Alternatives.

Alternatives, Regionalized. Alternatives that would result in transporting wastes to various numbers of sites (fewer than the number of sites considered for the Decentralized Alternatives but greater than the number of sites considered for the Centralized Alternatives). In general, those sites that now have the largest volumes of a given waste type are considered as regional sites for treatment, storage, or disposal. More than one Regionalized Alternative is considered for all waste types.

Ambient Air Quality Standard. The prescribed level of a pollutant in the outside air that cannot be exceeded during a specified time in a specified geographical area. Established by both Federal and state governments (see "Air Pollutants, Hazardous").

American Indian Religious Freedom Act of 1978. This Act establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

Anticline. A convex upward fold of rock.

Applicable or Relevant and Appropriate Requirements (ARARs). Requirements, including cleanup standards, standards of control, and other substantive environmental protection requirements and criteria for hazardous substances as specified under Federal and state law and regulations, that must be met when complying with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

Aquifer. A body of rock or sediment sufficiently permeable to conduct groundwater and to yield significant quantities of water to wells and springs.

Aquitard. A less-permeable geologic unit in a stratigraphic sequence. The unit is not permeable enough to transmit significant quantities of water. Aquitards separate aquifers.

Arroyo. A gully or channel cut by an intermittent stream.

As Low As Reasonably Achievable (ALARA). An approach to control or manage radiation exposures (both individual and collective to the workforce and the public) and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit. It is a process that has as its objective the attainment of dose levels as far below applicable limits as possible.

Atomic Energy Act of 1954. A Federal statute that, along with other related legislation (including the Energy Reorganization Act of 1974 and the Department of Energy Organization Act of 1977), provides

U.S. Department of Energy with the authority for developing generally applicable standards for protecting the environment from radioactive materials.

Atomic Energy Commission (AEC). A five-member commission, established by the Atomic Energy Act of 1946, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished and all functions were transferred to the U.S. Nuclear Regulatory Commission and the Administrator of the Energy Research and Development Administration (ERDA). ERDA was later terminated and its functions vested by law in the Administrator were transferred to the Secretary of Energy.

Attainment Area. An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the Clean Air Act. An area may be an attainment area for one pollutant and a nonattainment area for others (see "Nonattainment Area").

Background Level. The value assigned to the quantity of particulate or gaseous material in ambient air that originates from natural sources uninfluenced by the activity of man.

Background Radiation. Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices.

Baseline. *See* **Affected Environment.** *See* **Alternative, No Action.**

Basement Rocks. The undifferentiated complex of rocks that underlies the rocks of interest in an area. In many places the rocks of the complex are igneous and metamorphic and of Precambrian Age.

Best Available Technology (BAT). The preferred technology for treating a particular process liquid waste containing radioactive material so that the final waste stream will contain radionuclide concentrations no greater than the Derived Concentration Guide reference values at the point of discharge to a surface waterway.

Best Demonstrated Available Technology (BDAT). Earlier demonstrations have shown that incineration, vitrification, and aqueous treatment are effective in reducing the concentration of hazardous materials in waste shipments to levels acceptable for land disposal technologies. Concentration levels are set by the Land Disposal Restrictions standards stipulated in the Hazardous and Solid Waste Disposal Act of 1984. The U.S. Environmental Protection Agency established the Land Disposal Restrictions standards on the basis of BDATs rather than risk-based or health-based standards.

Beta Particle. An elementary subatomic particle emitted from a nucleus during radioactive decay, with a single electrical charge and a mass equal to 1/1,837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta particle radiation may cause skin burns, and beta particle emitters are harmful if they enter the body. Beta particles are easily stopped by a thin sheet of metal or plastic.

Bounding. In the context of accident analysis, bounding is a term used to identify conservative assumptions that will likely overestimate actual risks or consequences.

Calcination. An inorganic material is heated in a calciner to high temperatures but without fusing in order to drive off volatile matter (to remove organic material) or to effect changes (as oxidation or pulverization or to convert it to nodular form). Calciners and nodulizing kilns are considered to be similar units.

Cancer. A group of diseases characterized by uncontrolled cellular growth. Increased incidence of cancer can be caused by exposure to radiation or chemicals at sufficient concentrations and exposure durations.

Candidate Species. Plant or animal species that are not yet officially listed as threatened or endangered but are undergoing status review by the U.S. Fish and Wildlife Service. They are candidates for possible addition to the list of threatened and endangered species.

Canister. A metal receptacle surrounding the waste form that facilitates handling, storage, transportation, and/or disposal.

Carbon Monoxide (CO). A colorless, odorless gas that is toxic if breathed in high concentration over a period of time.

Case. With respect to an Environmental Impact Statement, a case is analogous to an alternative (see "Alternative"). The term "case" is used when several alternatives are predominantly similar; e.g., construction of a given plant at one site, at two sites, at three sites, etc.

Cask (Radioactive Materials). As defined by the U.S. Environmental Protection Agency, a cask is a thick-walled container (usually lead) that meets all applicable regulatory requirements for transporting radioactive materials.

CERCLA. *See* **Comprehensive Environmental Response, Compensation, and Liability Act.**

Characterization. The determination of waste composition and properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done for the purpose of determining appropriate storage, treatment, handling, transportation, and disposal requirements.

Class I Area. Under the Clean Air Act, any Federal land that is classified or reclassified "Class I." The designation applies to pristine areas, such as national parks and wilderness areas, where substantial growth is effectively precluded in order to avoid any degradation of the air quality.

Classified Waste. Waste materials, including weapons components and assemblies, designated by the U.S. Government, pursuant to Executive Order, statute, or regulation, that require protection against unauthorized information or material disclosure for reasons of national security. Additional security and safeguards management activities are required in the handling of these materials.

Clean Air Act. Federal Act that mandates the promulgation and enforcement of air pollution control standards for stationary sources and motor vehicles.

Clean Water Act of 1972, 1987. Federal Act regulating the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit, as well as regulating discharges to or dredging of wetlands.

Code of Federal Regulations (CFR). All Federal regulations in force are published in codified form in the Code of Federal Regulations.

Collective Dose. The sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem.

Collocated Workers. Workers in a fixed population outside the day-to-day safety management controls of a given facility area. In practice, this fixed population is normally the workers at an independent facility area located some distance from the reference facility area. Also, an individual assumed to be located 100 meters (328 feet) from where an accidental release occurs.

Combined Impact. Depending on the scope of the program concerned, a Programmatic Environmental Impact Statement may address more than one "Purpose and Need," each with its own set of alternatives. These several actions, however, may have common environments (e.g., two or more nuclear waste types being managed at the same site). The sum of these impacts with respect to the site concerned are combined impacts, as opposed to cumulative impacts (see "Cumulative Impacts"), which incorporate the site-specific impacts of activities not otherwise related to the action(s) and alternatives in question.

Commercialization. In this PEIS, commercialization refers to the use of a waste management facility that is owned and operated by a private entity (or State) that treats, stores, or disposes of waste from a variety of sources for a fee.

Committed Dose Equivalent (CDE). The calculated dose equivalent projected to be received by a tissue or organ over a 50-year period after an intake of radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem.

Committed Effective Dose Equivalent (CEDE). The sum of the committed dose equivalents to various tissues in the body, each multiplied by its weighting factor. It does not include contributions from external dose. Committed effective dose equivalent is expressed in units of rem.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). A Federal law (also known as "Superfund") that provides a comprehensive framework to deal with past or abandoned hazardous materials. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment that could endanger public health, welfare, or the environment, as well as the cleanup of inactive hazardous waste disposal sites. CERCLA has jurisdiction over any release or threatened release of any "hazardous substance" to the environment. Under CERCLA, the definition of "hazardous" is much broader than under the Resource Conservation and Recovery Act, and the hazardous substance need not be a waste. If a site meets the CERCLA requirements for designation, it is ranked along with other "Superfund" sites and listed on the National Priorities List. This ranking and listing is the U.S. Environmental Protection Agency's way of determining which sites have the highest priority for cleanup.

Contact-Handled Waste. Waste with a surface dose rate that does not exceed 200 millirems/hour.

Contamination. The deposition of unwanted radioactive or hazardous material on the surfaces of structures, areas, objects, or personnel.

Cradle-to-Grave. In the context of waste management, cradle-to-grave means from the time of generation through permanent disposal.

Criteria Air Pollutant. One of six air pollutants for which National Ambient Air Quality Standards are established by the U.S. Environmental Protection Agency under Title I of the Federal Clean Air Act. The six pollutants are sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, particulate matter (equal to or smaller than 10 microns in diameter), and lead.

Cultural Resources. Archaeological sites, architectural features, traditional-use areas, and Native American sacred sites or special-use areas.

Cumulative Impact. In an Environmental Impact Statement, the impact on the environment that results from incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR Part 1508.7) (see "Combined Impact").

Curie (Ci). The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations/second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations/second.

Daughter Products. Nuclides formed by the radioactive disintegration of a radionuclide (parent).

Deactivation. A technology applied to a hazardous substance to mitigate its hazardous characteristics, such as ignitability, corrosivity, or reactivity.

Decommissioning. The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

Decontamination. The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive contamination from facilities, soil, or equipment by washing, chemical action, mechanical cleaning, or other techniques.

Depleted Uranium. Uranium whose content of the isotope uranium-235 is less than 0.7%, which is the uranium-235 content of naturally occurring uranium.

Derived Concentration Guide (DCG). The concentration of a radionuclide in air or water that, under conditions of continuous exposure by ingestion of water, submersion in air, or irradiation, would result in an effective dose equivalent of 100 millirem for 1 year of exposure. DCG values are listed in DOE Order 5400.5. DOE drinking water standards are 4% of the DCG values for ingestion, and thus meet the criterion of 4 millirem/year.

Disposal. Emplacement of waste in a manner that ensures protection of human health and the environment within prescribed limits for the foreseeable future with no intent of retrieval and that requires deliberate action to regain access to the waste.

Disposal Facility. A facility or part of a facility at which hazardous, radioactive, or solid waste is intentionally placed into or on any land or water, and at which waste is intended to permanently remain after closure.

Disposition, Final. The ultimate solution to disposition of nuclear or hazardous waste: it will never again require handling and/or movement. For a given volume of waste, the final disposition may be represented by recycling, reprocessing, incineration, or burial (see "Storage" and "Storage, Long-Term").

Disproportionate. Neither DOE nor the Federal Working Group on Environmental Justice has yet issued final guidance on interpreting the provisions of the Executive Order on Environmental Justice, nor has there been a judicial interpretation of the term "disproportionate" within the context of environmental justice. In general use, disproportionate refers to a condition of disparity, or a lack of symmetry in the relation of one part of an entity to another part or to the whole with respect to magnitude, quantity, or degree. For purposes of the environmental justice analysis in the WM PEIS, the use of the term refers to any distribution of impacts across minority, low-income, or Native American populations that may be substantially greater in magnitude or quantity than that experienced by the general population. A high or adverse impact (or risk or rate of impact) is disproportionate when it significantly exceeds, for a low-income, minority, or Native American community, the same type of impacts in the larger community (for environmental impacts) or the risk or rate to the general population and, where available, to another appropriate comparison group (for health impacts).

Dose (or Radiation Dose). The amount of energy deposited in body tissue as a result of radiation exposure. Various technical terms, such as absorbed dose, collective dose, dose equivalent, and effective dose equivalent, are used to evaluate the amount of radiation an exposed person receives. Each of these terms is defined in this glossary.

Dose Equivalent. (a) That number (corrected for background) zero (minimal or negligible) and above, that is recorded as representing an individual's dose from external radiation sources or internally deposited radioactive materials determined in accordance with DOE Order 5480.1B, Chapter XI, Requirements. (b) The product of absorbed dose in rads in tissue and a quality factor. Dose equivalent is expressed in units of rem. (c) The product of the absorbed dose, the quality factor, and any other modifying factors. The dose equivalent is a quantity for comparing the biological effectiveness of different kinds of radiation (based on the quality of radiation and its spacial distribution in the body) on a common scale. The unit of dose equivalent is the rem. A millirem (mrem) is one thousandth (0.001) of a rem.

Ecological Impact. The effect that a manmade or natural activity has on living organisms and their nonliving (abiotic) environment.

Ecotoxicity. A measure of the ecological effects of chemicals.

Effective Dose Equivalent (EDE). The summation of the products of the dose equivalent received by specified tissues (or organs) of the body and a tissue-specific weighing factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighing factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body. Weighing factors are: 0.25 for gonads, 0.15 for breast, 0.12 for red bone marrow, 0.12 for lungs, 0.03 for thyroid, 0.03 for bone surface, and 0.06 for each of the other five organs receiving the highest dose equivalent. Effective dose equivalent is expressed in units of rem.

Effects (40 CFR Part 1508.8). "Effects" include: (a) direct effects, which are caused by the action and occur at the same time and place; (b) indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. Effects and impacts as used in the Council on Environmental Quality regulations are synonymous. Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial (see "Human Environment").

Effluent. A gas or fluid discharged into the environment.

EIS. *See* **Environmental Impact Statement.**

Emission Standard. A permit or regulatory requirement contained in 40 CFR Part 60 or 40 CFR Part 61 (that sets forth the National Emission Standards for Hazardous Air Pollutants), that limits the quantity, rate, or concentration of emissions on a continuous basis, including any requirements that limit opacity, prescribe equipment, set fuel specifications, or prescribe operation or maintenance procedures to ensure continuous emission control.

Endangered Species. Any species or subspecies of animal or plant whose survival is threatened with extinction throughout all or a significant portion of its range.

Endpoints. The types of potential adverse health effects evaluated in the health risk analysis. These effects include cancer incidence, cancer fatality, genetic effects, physical trauma injury and fatality, and noncancer effects (e.g., headaches, dermal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and development toxicity).

Engineered Barriers. Manmade components in a disposal system designed to prevent the release of radionuclides into the geologic medium involved. This term includes the radioactive waste form, radioactive waste containers, and other materials placed over and around such containers. A manmade structure or device that is intended to improve the land disposal facility's ability to meet performance objectives.

Enriched Uranium. Uranium that has greater amounts of the fissionable isotope uranium-235 than occurs naturally. Naturally occurring uranium is 0.72% uranium-235.

Environment. The sum of all external conditions affecting the life, development, and survival of an organism.

Environmental Impact Statement (EIS). A report by Federal agencies, prepared in accordance with the National Environmental Policy Act, that documents the information required to evaluate the environmental impact (both positive and negative effects) of a proposed project ("action"). Such a report informs decision makers and the public of the reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the environment. The draft EIS (DEIS) is circulated for public comment before the final EIS (FEIS) is prepared.

Environmental Justice. The fair treatment of people of all races, cultures, and income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (U.S. Environmental Protection Agency Office of Environmental Justice Small Grants Programs, Pre-Application Kit for Assistance, FY 1995).

Environmental Monitoring. The process of sampling and analyzing environmental media in and around a facility being monitored to (a) confirm compliance with performance objectives and (b) detect any contamination entering the environment early enough to facilitate timely remedial action.

Environmental Restoration. Cleanup and restoration of sites, and decontamination and decommissioning of facilities contaminated with radioactive and/or hazardous substances during past production, accidental releases, or disposal activities.

Environmental Restoration Program. A U.S. Department of Energy (DOE) subprogram concerned with all aspects of assessment and cleanup of both contaminated (radioactive and/or hazardous substances) DOE-owned facilities in use and of DOE sites that are no longer a part of active operations. Remedial actions, most often concerned with contaminated soil and groundwater and decontamination and decommissioning are responsibilities of this program.

Epidemiology. Study of the distribution of disease or other health-related states and events in human populations, as related to age, sex, occupation, ethnic, and economic status in order to identify and alleviate health problems and promote better health.

Exceedance. A value that goes over a prescribed limit.

Exposure Index. The sum of all ratios that compare the estimated exposure concentration of a particular noncarcinogenic chemical to an appropriate occupational exposure limit for that chemical.

Exposure Pathways. The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium such as air or water is also included.

External Dose Rate. The radiation dose from a shipping package delivered per unit time (e.g., rem per year).

Facility. (a) Any equipment, structure, system, process, or activity that fulfills a specific purpose. Examples include accelerators, storage areas, research devices, nuclear reactors, production or processing plants, conversion plants, windmills, radioactive waste disposal systems and burial grounds, testing laboratories, research laboratories, transportation activities, and accommodations for analytical examinations of irradiated and nonirradiated components. (b) Buildings and other structures; their functional systems and equipment, including site development features such as landscaping, roads, walks, and parking areas; outside lighting and communications systems; central utility plants; utilities supply and distribution systems; and other physical plant features. (c)(1) Any building, structure, installation, equipment, pipe, or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, or aircraft, or (2) any site or area where a hazardous substance has been deposited, stored, disposed of, or placed, or otherwise come to be located; but does not include any consumer product in consumer use or any vessel (see "Site").

Fault. A fracture in the earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

Federal Facility Compliance Act (FFCAct). Federal law signed in October 1992 amending the Resource Conservation and Recovery Act. The objective of the FFCAct is to bring all Federal facilities into compliance with applicable Federal and state hazardous waste laws, to waive Federal sovereign immunity under those laws, and to allow the imposition of fines and penalties. The law also requires the U.S. Department of Energy to submit an inventory of all its mixed waste and to develop a treatment plan for mixed wastes.

Federal Land Management Policy Act of 1976. Act that provides for the periodic and systematic inventory of public lands and their resources and for projecting their present and future use through a land use planning process coordinated with Federal and state planning efforts. Among other things, it encourages management on the basis of multiple uses and protection of the quality of scenic, historical, ecological, environmental, air and atmospheric, water resources, and archaeological values.

Federally Listed Species. *See* **Threatened Species, Endangered Species,** and **Candidate Species.**

Fines. Finely crushed or powdered material; i.e., very small particles in a mixture of various sizes.

Fission. The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

Floodplain. The lowlands and relatively flat areas adjoining inland and coastal waters including, at a minimum, that area inundated by a 1% or greater chance flood in any given year. The base floodplain is defined as the 100-year (1.0%) floodplain. The critical action floodplain is defined as the area inundated on average once every 500 years (0.2%).

Fugitive Emissions. Emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

Gamma Ray. High-energy, short-wavelength electromagnetic radiation of nuclear origin (radioactive decay) similar to x-rays. Gamma rays are true rays of energy, in contrast to alpha and beta radiation, and they are the highest penetrating of the three common types of radioactive decay. They are best stopped or shielded against by dense materials, such as lead or depleted uranium.

Gaussian Plume. The distribution of material (a plume) in the atmosphere resulting from the release of pollutants from a stack or other source. The distribution of concentrations about the centerline of the plume, which is assumed to decrease as a function of its distance from the source and centerline (Gaussian distribution), depends on the mean wind speed and atmospheric stability.

General Conformity Rule. U.S. Environmental Protection Agency rule that establishes minimal levels for criteria air pollutant emissions, in tons per year, based on the air quality control region's nonattainment designation.

Genetic Effects. The outcome resulting from exposure to mutagenic chemicals or radiation that results in genetic changes in germ line or somatic cells. Effects on genetic material in germ line (sex cells) cause trait modifications that can be passed from parents to offspring. Effects on genetic material in somatic cells result in tissue or organ modifications (e.g., liver tumors) that do not pass from parents to offspring.

Geologic Repository. A system intended to be used for, or may be used for, the disposal of radioactive waste or spent nuclear fuel in excavated geologic media. A geologic repository includes (a) a geologic repository operating area, and (b) the portion of the geologic setting that provides isolation. A near-surface disposal area is not a geologic repository.

Greater-Than-Class-C Waste (GTCC). Low-level radioactive waste that is generated by the commercial sector and that exceeds U.S. Nuclear Regulatory Commission concentration limits for Class-C low-level waste, as specified in 10 CFR Part 61. DOE is responsible for disposing of Greater-Than-Class-C wastes from U.S. Department of Energy nondefense programs.

Groundwater. In general, all water contained in the ground. Water held below the water table available to freely enter wells.

Habitat. Area where a plant or animal lives.

Half-Life (Radiological). The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; this varies for specific radioisotopes from millionths of a second to billions of years.

Hazard Index. The sum of ratios that compare the estimated concentration of a noncarcinogenic chemical to which an individual may be exposed to a criterion presumed to be protective of human health against noncancer toxicity.

Hazard Quotient. The ratio of the exposure concentration (or dose) of a single substance to the reference concentration (or reference dose) for that substance; hazard quotients are used by the U.S. Environmental Protection Agency to measure the risk of noncancer health effects and are independent of cancer risk, which is calculated only for those chemicals identified as carcinogens.

Hazardous Air Pollutants (HAPs). U.S. Environmental Protection Agency definition: Air pollutants that are not covered by ambient air quality standards but that, as defined in the Clean Air Act, may reasonably be expected to cause or contribute to irreversible illness or death. Such pollutants include asbestos, beryllium, mercury, benzene, coke oven emissions, radionuclides, and vinyl chloride. Office of Environmental Safety and Health definition: Air contaminants to which no ambient air quality standard is applicable and that causes, or contributes to, air pollution that may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible or incapacitating reversible, illness. Hazardous air pollutants are regulated by 40 CFR 61 (Regulations on National Emission Standards for Hazardous Air Pollutants).

Hazardous Materials Transportation Act of 1975, as Amended. Act that provides the U.S. Department of Transportation the authority to establish standards on any safety aspect of the transport of hazardous (including radioactive) materials by any mode in interstate and foreign commerce.

Hazardous Substance. Any substance that, when released to the environment in an uncontrolled or unpermitted fashion, becomes subject to the reporting and possible response provisions of the Clean Water Act and the Comprehensive Environmental Response, Compensation, and Liability Act.

Hazardous Waste (HW). Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

Heavy Metals. Metallic or semimetallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations.

High-Efficiency Particulate Air (HEPA) Filter. A filter with an efficiency of at least 99.95% used to separate particles from air exhaust streams prior to releasing that air into the atmosphere.

High-Level Waste (HLW). The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

Human Environment (40 CFR Part 1508.14). "Human environment" shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment. This means that economic or social effects are not intended by themselves to require preparation of an Environmental Impact Statement (EIS). When an EIS is prepared and economic or social and natural or physical environmental effects are interrelated, then the EIS will discuss all of these effects on the human environment.

Human Health Risk. A measure of the probability that adverse effects, or impacts, on human health will occur as a result of a given hazard.

Hypothetical Farm Family. An imaginary family assumed to live 300 meters downgradient of the center of a waste disposal unit. The family farms, grows, and consumes its own crops and livestock and uses groundwater for watering crops and animals—an estimated maximum exposure scenario taking place in the future at a time when institutional controls no longer exist. The scenario is analyzed to determine potential upper-bound exposures by ingestion of contaminated groundwater.

Hypothetical Intruder. An imaginary adult who drills a well directly through a disposal unit to the groundwater. As a result of the drilling, contaminated soil from within the unit is brought to the surface where it mixes with the top layers of the surface soil. The individual farms the land and eats the crops. The intruder scenario occurs after the failure of institutional control. This is consistent with the analysis required for disposal facilities under DOE Order 5820.2A.

Impact. In an Environmental Impact Statement, the positive or negative effect of an action (past, present, or future) on the environment. Environmental impacts are usually categorized as (a) natural environment (land use, air quality, water resources, geological resources, ecological resources, and aesthetic and scenic resources), or (b) human environment (infrastructure, economics, social, and cultural). Within an Environmental Impact Statement, cost; health risks; transportation and transportation accidents; and treatment, storage, and disposal facility accidents are treated separately from environmental impacts.

Impact Attribute. Environmental impacts are broadly defined as those affecting the "natural and physical environment and the relationship of people thereto." If natural and physical attributes are involved, economic and social impacts may be brought into play as appropriate. More specifically, these attributes include geology and soils, water resources, air quality, ecological resources, socioeconomic and land uses, infrastructure, cultural resources, the local transportation network, and the level of radionuclide and radiation exposure.

Incineration. The efficient burning of combustible solid and liquid wastes to destroy organic constituents and reduce the volume of the waste. Incinerators are designed to burn with extremely high efficiency. The greater the burning efficiency, the cleaner the air emission. Incineration of radioactive materials does not destroy the radionuclides but does significantly reduce the volume of the waste matrix. High-efficiency particulate air filters are used to prevent radionuclides and heavy metals from escaping from the stack into the atmosphere.

Increased Cancer Incidence Effects. An air concentration of hazardous waste containing carcinogens above which an exposed person has an increased carcinogenic risk of 1 in 1 million (1E–06) or higher.

Individual Health Risk Impacts. Impacts focusing on the probability that the maximally exposed individual within each receptor population would experience an adverse health impact. These impacts include the probability of a cancer fatality, the probability of cancer incidence, and the probability of genetic effects.

Inventory Waste. The accumulated waste remaining from the development and production of U.S. nuclear weapons, i.e., waste that is currently in warehouse storage, retrievable storage on bermed pads, or disposed of in trenches.

Isotope. A variation of an element that has the same number of protons, but a different weight because the number of neutrons differs from that of its other isotope(s). A given element may have many isotopes. For example, uranium occurs naturally in three forms: uranium-234 (142 neutrons), uranium-235 (143 neutrons), and uranium-238 (146 neutrons); each of these isotopes has 92 protons. Various isotopes of the same element may have different radioactive behaviors—some are highly unstable (i.e., they decay spontaneously and/or emit radiation) (see "Radioisotope" and "Radiation").

Land Disposal Restrictions (LDRs). Restrictions on the disposal of waste that is hazardous under the Resource Conservation and Recovery Act. LDRs include technology-based or performance-based treatment standards that must be met before hazardous waste can be land disposed. The regulations in 40 CFR Part 268 address LDRs.

Land-Use Planning. A decision-making process to determine the future or end use of a parcel of land, considering such factors as current land use, public expectations, cultural considerations, local ecological factors, legal rights and obligations, technical capabilities, and costs.

Life Cycle. The entire time period from generation to permanent disposal or elimination of waste.

Low-Income Population. A census tract within the 80-kilometer (50-mile) zone of impact at each of the 17 U.S. Department of Energy sites that has a low-income population proportion greater than the national average of 13.1%.

Low-Income Status. Based on U.S. Census Bureau data definitions of individuals below the poverty line. The poverty line is defined by a statistical threshold that considers family size and income. For 1990, the poverty threshold for a family unit consisting of four individuals, based on 1989 income, was $12,674. Other poverty thresholds are provided by the U.S. Census Bureau for larger and smaller family sizes.

Low-Level Waste (LLW). Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section 11(e)(2) of the Atomic Energy Act). Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided that the concentration of transuranic is less than 100 nCi/g.

Low-Level Mixed Waste (LLMW). Waste that contains both hazardous waste under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954 (42 USC 2011, *et seq.*).

Maximally Exposed Individual (MEI). A hypothetical individual whose location and habits maximize the highest total radiation dose and/or chemical intake for all exposure routes (e.g., inhalation, ingestion, direct exposure) over the individual's lifetime. Two types of MEIs are considered in this PEIS. One is the offsite MEI, a member of the general population located within 80 kilometers (50 miles) of an onsite facility. The other is the MEI of the noninvolved worker population, that is, the population of onsite employees not directly involved in waste handling activities.

Millirem. One thousandth of a rem (see "Rem").

Minimum Treatment. The least amount of treatment required to meet waste acceptance criteria for disposal and, if shipped to another site, packaging requirements for transportation. Minimum treatment includes solidification of liquids and fines, and packaging.

Minority Population. Includes individuals who report themselves as belonging to any of the following racial groups: Black (reported their race as "Black or Negro," or reported entries such as "African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian"); American Indian, Eskimo, or Aleut; Asian or Pacific Islander, or "Other Race." Individuals identifying themselves as of Hispanic origin are also included in the minority category. Hispanics can be of any race, however. To avoid double-counting minority Hispanic individuals, only white Hispanics were included in the number of racially based minorities in a tabulation, since nonwhite Hispanics had already been counted under their minority racial classification. For this analysis, minority populations consist of any census tract within the 80-kilometer (50-mile) zone of impact at each of the 17 U.S. Department of Energy sites that has a minority population proportion greater than the national average of 24.4%.

Mitigation (40 CFR Part 1508.20). "Mitigation" includes: (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or (e) compensating for the impact by replacing or providing substitute resources or environments.

Mixed Waste. Waste that contains both (a) hazardous waste under the Resource Conservation and Recovery Act, and (b) source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954 (see "Low-Level Mixed Waste").

Most Exposed Lifetime (MEL). The 70-year lifetime out of the 143 lifetimes evaluated during which the highest exposures are estimated to occur for the hypothetical farm family.

Multimedia Environmental Pollutant Assessment System (MEPAS). For the groundwater pathway, various computer models, including MEPAS, are used to simulate environmental transport of contaminants from the source (waste disposal location) to groundwater to potential receptors. Contaminant-specific unit rate of transfer (flux) rates out of the engineered disposal facility are used by MEPAS to simulate the transport of contaminants through the vadose zone (the area above the permanent groundwater level) and into the groundwater. The MEPAS model then predicts the environmental concentration of contaminants at various receptor locations as a function of time.

National Ambient Air Quality Standards (NAAQS). Air quality standards established by the Clean Air Act, as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety, and the secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emission Standards for Hazardous Air Pollutants (NESHAPS). A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These were implemented in the Clean Air Act Amendments of 1977.

National Environmental Policy Act (NEPA) (10 CFR Part 1021.1). This 1969 legislation (42 U.S.C. 4321 *et seq.*) establishes national policies and goals for protecting the environment. Section 102(2) of NEPA contains certain procedural requirements directed toward attaining such goals. In particular, all Federal agencies are required to give appropriate consideration to the environmental effects of their proposed actions in their decision making and to prepare detailed environmental statements on recommendations or reports on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. Executive Order 11991 of May 24, 1977, directed the Council on Environmental Quality to issue regulations to implement the procedural provisions of NEPA.

National Historic Preservation Act of 1966, as Amended. This Act directs Federal agencies to consider the effects of their programs and projects on properties listed or eligible for the National Register of Historic Places. It does not require any permits, but pursuant to Federal code, if a proposed action could impact an archaeological, historic, or architectural resource, it mandates consultation with the proper agencies.

National Pollutant Discharge Elimination System (NPDES). Federal permitting system required for hazardous effluents regulated through the Clean Water Act, as amended.

National Priorities List (NPL). A formal listing of the Nation's most hazardous waste sites, as established under the Comprehensive Environmental Response, Compensation, and Liability Act, that have been identified for remediation.

National Register of Historic Places (NRHP). The official list of historic properties (districts, sites, buildings, structures, and objects) maintained by the Secretary of the Interior deserving preservation because of their local, state, or national significance in American history, architecture, archaeology, engineering, and culture. Properties listed or eligible for the National Register are protected by the National Historic Preservation Act of 1966, as amended.

Native American Grave Protection and Repatriation Act of 1990. Act requiring Federal agencies and Federally funded museums to repatriate human remains, sacred objects, and objects of cultural patrimony to the culturally affiliated Native American groups. This includes repatriation of cultural items in collections, proof of consultation with appropriate Native American groups for excavation on Federal or tribal lands, and notification of the Federal Land Manager and appropriate Native American group when an inadvertent discovery is made on Federal or tribal land. Any cultural items excavated after November 16, 1990, pertaining to this Act, are owned by lineal descendants.

NEPA. *See* **National Environmental Policy Act.**

Neutron. An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and proton.

Nitrogen Oxides (NO_x). Gases formed in great part from atmospheric nitrogen and oxygen when combustion takes place under conditions of high temperature and high pressure; considered a major air pollutant. Two major nitrogen oxides, nitric oxide (NO), and nitrogen dioxide (NO_2), are important airborne contaminants. In the presence of sunlight, nitric oxide combines with atmospheric oxygen to produce nitrogen dioxide, which in high enough concentrations can cause lung damage.

Nonattainment Area. An air quality control region (or portion thereof) in which the U.S. Environmental Protection Agency has determined that ambient air concentrations exceed National Ambient Air Quality Standards for one or more criteria pollutants.

NPDES. *See* **National Pollutant Discharge Elimination System.**

Nuclear Waste Policy Act of 1982, as Amended. This Act authorizes Federal agencies to develop a geologic repository for the permanent disposal of spent nuclear fuel and high-level radioactive waste. The Act specifies the process for selecting a repository site and constructing, operating, closing, and decommissioning the repository. The Act also establishes programmatic guidance for these activities.

Nuclide. A general term referring to all known isotopes, both stable (279) and unstable (about 5,000), of the chemical elements (see "Isotope" and "Radioisotope").

Offsite Population. For facility accident analyses, the collective sum of individuals located within an 80-kilometer (50-mile) radius of a facility and within the path of the plume with the wind blowing in the most populous direction.

Onsite. The same or geographically contiguous property that may be divided by public or private right-of-way, provided the entrance and exit between the properties is at a crossroads intersection, and access is by crossing as opposed to going along the right-of-way. Noncontiguous properties owned by the same person but connected by a right-of-way that he/she controls and to which the public does not have access is also considered onsite property.

Ozone (O_3). The triatomic form of oxygen; in the stratosphere, ozone protects the Earth from the sun's ultraviolet rays, but in lower levels of the atmosphere ozone is considered an air pollutant.

Paleontology. The study of fossils.

Paleozoic Era. Geologic time dating from 570 million to 245 million years ago when seed-bearing plants and vertebrates first appeared.

Particulate Matter. Any material, except uncombined water, that exists in a finely divided form as a liquid or solid.

Particulates. Particles in an aerosol stream, the larger of which usually can be removed by filtration.

PEIS. *See* **Programmatic Environmental Impact Statement.**

Playa. A dry lake bed in a desert basin or a closed depression that contains water on a seasonal basis.

Pleistocene Epoch. Geologic time that occurred approximately 1.8 to 10,000 years ago. Generally equated with the "Ice Age."

Plume. The three-dimensional area (usually in air or groundwater) containing measurable concentrations of a compound or element that has migrated from its source point.

Plutonium (Pu). A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombardment of uranium with neutrons and is used in the production of nuclear weapons.

PM_{10}. All particulate matter in the ambient air with an aerodynamic diameter less than or equal to a nominal 10 micrometers (10 microns). Particles less than this diameter are small enough to be breathable and could be deposited in lungs.

Pollution Prevention. The use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and wastes into land, water, and air. Pollution prevention includes practices that reduce the use of hazardous materials, energy, water, and other resources along with practices that protect natural resources through conservation or more efficient use.

Polychlorinated Biphenyls (PCBs). A class of chemical substances formerly manufactured as an insulating fluid in electrical equipment that is highly toxic to aquatic life. In the environment, PCBs exhibit many of the characteristics of dichloro diphenyl trichloroethane (DDT); they persist in the environment for a long time and accumulate in animals.

Population Dose. The overall dose to the offsite population.

Population Health Risk Impacts. Impacts focusing on the total number of persons in each population who may experience adverse health impacts if a particular alternative were implemented. These impacts include fatalities from physical hazards, cancer fatalities, cancer incidences, and genetic effects.

Potential Life-Threatening Concentration (PLC). An air concentration of hazardous waste above which exposed persons are at risk of potentially life-threatening health effects when exposed for the associated exposure period.

Potentially Adverse Effects Concentration (PAEC). An air concentration of hazardous waste above which exposed persons are at risk of any adverse effect, which may include mild transient effects such as headaches.

Precursor Pollutants. Pollutants that must be present in the atmosphere before chemical reactions take place and form the pollutant of interest. For example, nitrogen oxides, volatile organic compounds, and carbon monoxide are precursor pollutants to the formation of ozone.

Prevention of Significant Deterioration (PSD). Regulations established by the 1977 Clean Air Act Amendments to limit increases in criteria air pollutant concentrations above baseline.

Privatization. In this PEIS, privatization refers to the use of a DOE facility on a DOE site that is operated, maintained, and eventually decontaminated and decommissioned by a private entity who operates that waste management facility for the exclusive use of DOE and is reimbursed by DOE on a competitive, fixed-price basis. Privatization also includes the construction and subsequent operation of a new waste management facility by a private entity on a DOE site.

Programmatic Environmental Impact Statement (PEIS). A broad-scope Environmental Impact Statement that identifies and assesses the environmental impacts of a U.S. Department of Energy program. A PEIS may have several purposes (see "Purpose and Need") with distinct proposed actions and alternatives for each (see "Combined Impacts").

Proposed Action. The activity proposed to accomplish an agency's purpose and need (see "Purpose and Need"). An Environmental Impact Statement analyzes the environmental impacts of the proposed action and of reasonable alternatives to that action (see the various entries under "Alternatives"). A proposed action is described as a project and its related support operations to include preconstruction, construction, and operational activities, and postoperational requirements.

PSD. *See* **Prevention of Significant Deterioration.**

Public. Anyone outside the U.S. Department of Energy site boundary at the time of an accident or during normal operation. With respect to accidents analyzed in this Environmental Impact Statement, anyone outside the site boundary at the time of an accident.

Purpose and Need. In the context of an Environmental Impact Statement, the broad requirement to be met or goal to be achieved (with respect to a specific statutory authority) by the Federal agency concerned. The proposed action and its alternatives are means of accomplishing the purpose and need (see "Action" and "Alternative").

Quality Assurance. All those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or components will perform satisfactorily and safely in service. Quality assurance includes quality control, which is all those actions necessary to control and verify the features and characteristics of material, process, product, or service to specified requirements.

Quaternary. The period of geologic time since the end of the Pliocene, consisting of the Pleistocene and Holocene, from about 1.8 million years ago to the present.

Radiation. The release of energy in the form of particles and/or electromagnetic radiation resulting from the spontaneous nuclear decay of an unstable atomic nucleus.

Radioactive Waste. Waste managed for its radioactive content.

Radioactivity. The property or characteristic of material to spontaneously "disintegrate" with the corresponding release of energy in the form of particles and/or electromagnetic radiation (see "Radiation"). The unit of radioactivity is the curie.

Radioisotope. An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. Approximately 5,000 natural and artificial radioisotopes have been identified (see"Isotope").

Radionuclide. *See* **Radioisotope.**

Radon. Gaseous, radioactive element with the atomic number 86 resulting from the radioactive decay of radium. Radon occurs naturally in the environment, and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.

RCRA. *See* **Resource Conservation and Recovery Act.**

Record of Decision (ROD). A public document that records the final decision(s) on a proposed action. The Record of Decision is based in whole or in part on information and technical analysis generated either during the Comprehensive Environmental Response, Compensation, and Liability Act process or the National Environmental Policy Act process, both of which take into consideration public comments and community concerns. 40 CFR Part 1505.2 states, in part: "At the time of its decision or, if appropriate, its recommendation to Congress, each agency shall prepare a concise public record of decision. The record shall:

- State what the decision was.
- Identify all alternatives considered by the agency in reaching its decision, specifying the alternative or alternatives that were considered to be environmentally preferable. An agency may discuss preferences among alternatives based on relevant factors including economic and technical considerations and agency statutory missions. An agency shall identify and discuss all such factors including any essential considerations of national policy which were balanced by the agency in making its decision and state how those considerations entered into its decision.
- State whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not."

Recycling. Recycling techniques are characterized as use, reuse, and reclamation techniques (resource recovery). Use or reuse involves the return of a potential waste material either to the originating process as a substitute for an input material or to another process as an input material. Reclamation is the recovery of a useful or valuable material from a waste stream. Recycling allows potential waste materials to be put to a beneficial use rather than going to treatment, storage, or disposal.

Region of Influence (ROI). The physical area that bounds the environmental, sociological, economic, or cultural feature of interest for the purpose of analysis.

Regional Input-Output Modeling System (RIMS). The economic multipliers (for disposable income, output, and job years) used by the Programmatic Environmental Impact Statement team to assess the economic impact of waste management activities were derived from an 80-sector (80 industries) model based on the RIMS approach developed by the U.S. Department of Commerce.

Rem (Roentgen Equivalent Man). A unit of individual dose of absorbed ionizing radiation used to measure the effect on human tissue. The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of x-ray or gamma-ray exposure.

Remediation. Process of remedying a site where a hazardous substance release has occurred.

Remote-Handled Waste. Wastes whose external dose rate exceeds 200 millirem per hour.

Repository. A permanent deep geologic disposal facility for high-level or transuranic wastes and spent nuclear fuel.

Reprocessing. A recycling procedure in which the useful material is removed from spent nuclear fuel and reused, and the remaining material is disposed of as waste.

Resource Conservation and Recovery Act (RCRA). A Federal law addressing the management of waste. Subtitle C of the law addresses hazardous waste under which a waste must either be "listed" on one of the U.S. Environmental Protection Agency's (EPA's) hazardous waste lists or meet one of EPA's four hazardous characteristics of ignitability, corrosivity, reactivity, or toxicity, as measured using the toxicity characterization leaching procedure. Cradle-to-grave management of wastes classified as Resource Conservation and Recovery Act (RCRA) hazardous wastes must meet stringent guidelines for environmental protection as required by law. These guidelines include regulation of transportation, treatment, storage, and disposal of RCRA-defined hazardous waste. Subtitle D of the law addresses the management of nonhazardous, nonradioactive solid waste, such as municipal wastes.

Risk. Usually quantitative, sometimes qualitative expression of possible loss that considers both the probability that a hazard/event causes harm and the consequences (damage to life, health, property) of the event/hazard. It is usually described in terms of loss or injury over a given period of time.

Saltcake. Concentrated waste in the form of crystallized salts resulting from the evaporation of liquid high-level waste.

Scrubber. An air pollution control device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.

Seismicity. The tendency for the occurrence of earthquakes.

Shielding. A material interposed between a source of radiation and persons, equipment, or other objects in order to absorb radiation and thereby reduce radiation exposure. Depending on the type of radiation being shielded, typical materials include lead, steel, depleted uranium, concrete, and water.

Site. (1) A U.S. Government-owned property, including land, facilities, structures, and equipment, that usually is operated for DOE by a prime contractor that administratively reports to a U.S. Department of Energy (DOE) Operations Office; e.g., the Oak Ridge National Laboratory is operated by Martin Marietta and reports administratively to DOE's Oak Ridge Operations Office; the Los Alamos National Laboratory is operated by the University of California and reports administratively to DOE's Albuquerque Operations Office. (2) When qualified (for example, *release site*), an area of contaminated ground (see "Facility").

Socially Sensitive Action. One that includes a question(s) of environmental justice (see "Action" and "Environmental Justice").

Socioeconomics. The measure of an economy's (community's) ability to support its infrastructure (e.g., schools, roads, police) and standard of living (e.g., parks, cultural facilities). Usually used with respect to changes in this measure effected by significant changes in the local economy, such as shutdown of an established industry; opening of a new industry.

Sole Source Aquifer. An aquifer that supplies 50% or more of the drinking water of an area. As defined by the Safe Drinking Water Act, an aquifer that is the only source or potential source of drinking water in an area.

Solid Waste. Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, or agricultural operations or from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges that are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended, or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended (Public Law 94-580, 1004[27] [Resource Conservation and Recovery Act]).

Solidification. Treatment process that produces a monolithic block of waste with high structural integrity from excavated solid particulates, liquids, or sludge wastes.

Source Term. The type and quantity of pollutants released to the environment (e.g., air, water) from a specific source or group of sources.

Special-Case Waste. Waste generated by the U.S. Department of Energy that does not fit into any typical low-level waste management and is usually not suitable for near-surface disposal.

Spent Nuclear Fuel. Fuel that has been withdrawn from a nuclear reactor after irradiation, the constituent elements of which have not been separated.

Special Nuclear Material. As defined in Section 11 of the Atomic Energy Act of 1954, special nuclear material means (a) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the U.S. Nuclear Regulatory Commission determines to be special nuclear material or (b) any material artificially enriched by any of the foregoing.

Stakeholder. Any person or organization with an interest in or affected by U.S. Department of Energy activities. Stakeholders may include representatives from Federal agencies, state agencies, Congress, Native American Tribes, unions, educational groups, industry, environmental groups, other groups, and members of the general public.

State-Listed Species. Any species listed by a state government as threatened or endangered (see "Threatened Species," "Endangered Species," and "Candidate Species").

Storage. The collection and containment of waste or spent nuclear fuel (in such a manner as not to constitute disposal of the waste or spent nuclear fuel) for the purposes of awaiting treatment or disposal capacity (i.e., not short-term accumulation) (see "Storage, Long-Term," and "Disposition, Final").

Storage, Long-Term. The containment of waste (usually after undergoing treatment) for a period of years, possibly decades, until ultimate permanent disposal.

Targets. Refers to a variety of nonfuel components that are placed within a nuclear reactor or particle accelerator in order to produce a desired material.

Terrestrial. Pertaining to plants or animals living on land rather than in the water.

Tertiary Period. The first geologic period of the Cenozoic Era, dating from 66 million to about 5.5 million years ago. During this time, mammals became the dominant life form.

Thermal Treatment. Thermal destruction is the efficient burning of combustible solid and liquid wastes to destroy organic constituents and reduce the volume of the waste. The greater the destruction efficiency, the cleaner the air emissions. The thermal destruction technology assumed in the WM PEIS is incineration.

Threatened Species. Any species or subspecies of plant or animal that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Total Effective Dose Equivalent (TEDE). The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Toxic Air Pollutants (TAPs). Other toxic compounds regulated by the U.S. Environmental Protection Agency and state or local governments.

Toxic Substances Control Act (TSCA). Act authorizing the U.S. Environmental Protection Agency (EPA) to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by EPA before they are manufactured for commercial purposes.

Transuranic Waste (TRUW). Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, per gram of waste, with half-lives greater than 20 years, except for (a) high-level radioactive waste, (b) waste that the Secretary has determined, with concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; or (c) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

Treatment. Any method, technique, or process designed to change the physical or chemical character of the waste to render it less hazardous; safer to transport, store, or dispose of; or reduced in volume.

Treatment Facility. Land area, structures, and/or equipment used for treating waste or spent nuclear fuel.

Treatment Group. Refers to the grouping together of waste streams that receive treatment through the same sequence of treatment steps.

Type B Package. A Type B packaging together with its radioactive contents. An NRC-certified container that must be used for the transport of highly radioactive materials. Type B packaging must be able to withstand both normal and accident transport conditions without releasing its radioactive contents. These containers are tested under severe, hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and submersion in water.

Type B Shipping Cask. An NRC-certified cask with a protective covering that contains and shields radioactive materials, dissipates heat, prevents damage to the contents, and prevents criticality during normal shipment and accident conditions. It is used for transport of highly radioactive materials, and is tested under severe, hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and submersion in water.

Vadose Zone. The zone between the land surface and the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. Also called the zone of aeration and the unsaturated zone.

Vitrification. (a) A waste treatment process in which calcined or another decomposed form of waste is mixed with glass and fused into a solid mass. The resultant mass is expected to remain a stable and insoluble form for long time periods, and thus will be a leading candidate for the most benign waste form for disposal. (Vitrification with borosilicate glass is the Best Demonstrated Available Technology for high-level waste and certain mixed waste streams.) (b) The conversion of high-level waste materials into a glassy or noncrystalline solid for subsequent disposal. (c) The process of immobilizing waste that produces a glasslike solid that permanently captures the radioactive materials.

Volatile Organic Compounds (VOCs). A broad range of organic compounds such as benzene, chloroform, and methyl alcohol, often halogenated, that vaporize at ambient or relatively low temperatures.

Volume Reduction. Reduces the overall disposal volume of low-level waste by using a variety of treatment techniques. Volume reduction uses several different available technologies, including thermal destruction, compaction/supercompaction, size reduction, and evaporation/concentration. For low-level waste disposal, DOE evaluated the impacts associated with both shallow land burial and engineered disposal facilities.

Waste Acceptance Criteria (WAC). The requirements specifying the characteristics of waste and waste packaging acceptable to a waste receiving facility and the documents and processes the generator needs to certify that waste meets applicable requirements.

Waste Characterization. *See* **Characterization.**

Waste Generation. Any waste produced during a particular calendar year. This does not include waste produced in previous years that is being repacked, treated, or disposed of in the current calendar year. It does include any secondary waste (e.g., clothing, gloves, waste from maintenance operations) generated by treatment, storage, or disposal activities of previously generated wastes.

Waste Isolation Pilot Plant (WIPP). A facility in southeastern New Mexico being developed as the disposal site for transuranic and transuranic mixed waste, not yet in operation.

Waste Isolation Pilot Plant Land Withdrawal Act. A Federal statute (Public Law 102-579) that addresses issues associated with the Waste Isolation Pilot Plant (WIPP) as a disposal site for transuranic waste. Among other things, it withdraws the land comprising WIPP from usual public land laws and reserves it to the U.S. Department of Energy for uses associated with its being a disposal site for transuranic waste.

Waste Load. Inventory defined by waste type, current or to-be-generated, and/or physical or radiological characteristics, as the case may be. Expressed in a variety of units of weight, mass, volume, and/or activity, and sometimes specifying a treatment group.

Waste Management. The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated pollution prevention and surveillance and maintenance activities.

Waste Management Program. A U.S. Department of Energy (DOE) subprogram concerned with all aspects of waste management associated with radioactive and/or hazardous substances generated by DOE-owned facilities.

Waste Minimization. An action that economically avoids or reduces the generation of waste by source reduction, by reducing the toxicity of hazardous waste, by improving energy usage, or by recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

Waste Package. The waste, waste container, and any absorbent that are intended for disposal as a unit.

Waste Stream. A flow of waste materials with specific definable characteristics that remain the same throughout the life of the process generating the waste stream. A waste stream is produced by a single process or subprocess; however, that process or subprocess may be one that combines two or more input waste streams together to produce a single output waste stream.

Waste Type. The waste types being considered in this Programmatic Environmental Impact Statement are high-level waste, transuranic waste, low-level mixed waste, low-level waste, and hazardous waste (see specific waste type definitions).

Wastewater. Water that typically contains less than a 1% concentration of organic hazardous waste materials.

Wetland. Lands or areas exhibiting hydric soils, saturated, or inundated soil during some portion of the plant growing season, and plant species tolerant of such conditions (includes swamps, marshes, and bogs).

Worker, Facility. Any worker whose day-to-day activities are controlled by process safety management programs and a common emergency response plan associated with a facility or facility area. This definition includes any individual within a facility/facility area or its 0.6-kilometer (0.4-mile) exclusion zone. This definition can also include those transient individuals or small populations outside the exclusion zone but inside the radius defined by the maximally exposed collocated worker, if reasonable efforts to account for such people have been made in the facility or facility area emergency plan. For facility accident analyses, the facility worker is defined as an individual located 100 meters (328 feet) downwind of the facility location where an accidental release occurs.

Worker, Noninvolved. Workers on DOE sites who are not involved directly in waste management. In accident studies, these workers are assumed to be located some prescribed distance from the point of release.

Worker, Waste Management. Onsite employees working in a site's waste management facilities (e.g., treatment, storage, and disposal), including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste.

X-rays. Penetrating electromagnetic radiation with wavelengths shorter than those of visible light, usually produced by irradiating a metallic target with large numbers of high-energy electrons. In nuclear reactions, it is customary to refer to photons originating outside the nucleus as x-rays and those originating in the nucleus as gamma rays, even though they are the same.

CHAPTER 15
List of Appendices and Technical Reports

15.1 Appendices

The Waste Management Programmatic Environmental Impact Statement (WM PEIS) includes nine appendices. The following paragraphs include the letter designation and title of each of these appendices and provide a brief abstract of each.

Appendix A Public Comments to DOE's Proposed Revisions to the Scope of the WM PEIS

This appendix reproduces the Department's *Federal Register* notice of January 24, 1995 (in which the Department announced proposed modifications to the title and scope of the "Environmental Restoration and Waste Management PEIS"), and addresses the public's response to the notice. In summary, the Department proposed to eliminate the analysis of environmental restoration alternatives, focus primarily on the evaluation and analysis of waste management issues confronting the Department, and rename the analysis the "Waste Management PEIS."

Appendix B Environmental Restoration Wastes

This appendix provides an estimate of waste to be generated by environmental restoration activities throughout the DOE complex and discusses whether managing those potential waste loads would cause DOE management to make a different decision than would be made by the analysis of waste management wastes alone. The discussion focuses on the subset of environmental restoration wastes that will be transferred to the waste management program. The environmental restoration program generates low-level mixed, low-level, and transuranic wastes, all of which may affect the respective components of the waste management program. The environmental restoration program is not responsible for the management of high-level waste.

Appendix C Environmental Impacts Analysis Methods

This appendix describes the methods used to estimate costs and environmental impacts. It presents the methods in the context of the three-phase approach to the PEIS analysis. The appendix describes Phase-I of the analysis in which waste volumes and treatability groups are identified; treatment, storage, and disposal technologies and the engineering modules used to model those technologies are selected; and alternative-specific waste transportation requirements and waste loads are identified at each site, for each waste type. The appendix summarizes the outputs of the module-based engineering analysis produced in Phase II, which include discharges to the environment from treatment, storage, and disposal facilities; resource use and labor requirements; and facility and transportation costs. The appendix then describes in detail the impacts analysis methods that use the Phase II outputs to evaluate air quality, water resources, and ecological resources impacts, economic and social impacts, environmental justice concerns, and land use, infrastructure, and cultural resources impacts.

In accordance with the requirements of Executive Order 12898, DOE evaluated the potential for the WM PEIS program alternatives to cause disproportionately high and adverse human health or environmental effects to minority and low-income populations at the 17 major waste management sites and then reviewed the human health effects and environmental impacts associated with alternatives for the five waste types at those sites. This appendix provides the full details of the methods used to evaluate environmental justice impacts and presents maps showing the distribution of minority and low-income populations at the 17 sites. The maps are based on an analysis of 1990 U.S. Bureau of the Census files, which contain political boundaries, geographical features, and demographic information. Two sets of maps are provided, one for minority population distribution, and the other for low-income population distribution. Data were resolved to the census tract group level. Native American tribal lands located within 50 miles of each site also were identified and mapped. They are included where applicable with the minority population distribution maps.

Appendix D Waste Management Facility Human Health Risk Estimates

This appendix summarizes the human health impacts posed by stationary sources of waste at DOE waste management facilities. The purpose of this human health risk evaluation is to provide projections of the health risks posed by the waste consolidation options being considered for DOE waste management facilities in this WM PEIS. This information, in conjunction with other WM PEIS impacts (e.g., transportation risks, ecological risks, air, water, and socioeconomic impacts) and costs, is intended to aid in determining the advantages and disadvantages of the various waste consolidation options.

Appendix E Radioactive and Hazardous Waste Transportation Risk Assessment

This appendix presents a summary of the transportation-related human-health risk assessment conducted for the WM PEIS and provides supplementary references to more detailed sources of information for all types of waste. The assessment of the risks associated with the transportation of radioactive waste is described in Part I. The risk assessment for the transportation of hazardous waste (HW) is described in Part II.

Transportation is an integral component of the alternatives being considered for each type of radioactive waste in the WM PEIS. For some alternatives, radioactive waste would be shipped among the DOE sites at various stages of the treatment, storage, and disposal process. The magnitude of the transportation-related activities varies with each alternative, ranging from minimal transportation for Decentralized approaches to significant transportation for some Centralized approaches. The human health risks associated with transporting various waste materials were assessed to ensure a complete appraisal of the impacts of each WM PEIS alternative being considered.

The transportation of radioactive waste and HW involves a risk to both crew members and members of the public. Part of this risk results from the nature of transportation itself, independent of the radioactive or hazardous characteristics of the cargo. These risks can be viewed as "vehicle-related" risks. On the other hand, the transportation of radioactive waste and HW may pose an additional risk because of the characteristics and potential hazards of the material itself. These risks are considered to be "cargo-related" risks. In this appendix, the risks to human health from both vehicle- and cargo-related causes are assessed.

Appendix F Treatment and Storage Facility Accidents

This appendix documents the methodology and computational framework for facility accident analyses performed for the WM PEIS. The output of the facility accident analyses is a specification for each waste type of the accidents potentially important to human health risk, an assessment of the frequencies of these accidents, and an evaluation of the radiological and chemical source terms resulting from these accidents.

A radiological source term is defined by specifying the amount (in curies) of each radionuclide released during an accident, where release is conservatively assumed to be instantaneous. A chemical source term is defined by specifying the rate and duration of release for each toxic chemical released during an accident. The frequencies of the accidents and the results of the source term evaluation are provided as input to the WM PEIS for calculations of the human health and risk impacts.

The methodology considers the spectrum of accident sequences that could occur in activities covered by the WM PEIS and uses a graded approach emphasizing the risk-dominant scenarios to facilitate discrimination among the various WM PEIS alternatives. Although it allows reasonable estimates of the risk impacts associated with each alternative, the main goal of the accident analysis methodology is to allow reliable estimates of the relative risks among the alternatives. Rather than developing all accident sequences in detail, the accident models are systematically applied to approximate the key source term parameters as a function of (1) the phenomenology and severity of the accident, (2) the process parameters, (3) the characteristics of the facility, and (4) the properties of the waste types. This allows many of the uncertainties in the data that are reflected in estimates of absolute risk to be canceled in estimates of relative risk providing a sufficient and scrutable basis for discriminating among alternatives.

Appendix G Pollution Prevention

DOE has a waste reduction policy that requires DOE sites to engage in waste minimization and pollution prevention and to have an established program for implementing this policy. The DOE Office of Waste Management (WM) is responsible for coordinating and consolidating this waste reduction policy. The purpose of this appendix is to discuss how DOE's associated programs and practices may affect the waste loads that WM facilities receive and, consequently, the need for the facilities. It contains estimates of reductions in waste loads, risks associated with WM activities, and WM costs resulting from these waste minimization practices.

Within DOE, the activities concerned are those that involve source reduction and recycling of all waste and pollutants, and include those practices that reduce or eliminate pollutants through increased efficiency in the use of raw materials, energy, water, or other resources, or the protection of natural resources by conservation. Source reduction means any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment before recycling, treatment, or disposal; and any practice that reduces the hazards to public health and the environment associated with the release of such substance, pollutants or contaminants.

Appendix H Technology Development

This appendix addresses the potential impact of technology development on the alternatives being considered in the WM PEIS. The availability, and the projected availability, of appropriate technologies govern what can be cleaned up, how, and how soon. DOE's objective is to manage its waste with the greatest effectiveness, efficiency, and lowest tolerable risks to people (health, safety, jobs), as well as to the environment. In many cases, the development of new technologies presents the best hope for ensuring a substantial reduction in risk to the environment and improved safety for workers and the public within realistic financial constraints. This appendix outlines the developmental approach taken by DOE's Office of Environmental Management through its Office of Technology Development and discusses selected examples of emerging technologies that may influence the WM PEIS alternatives and/or mitigate the impact of associated activities.

The Office of Technology Development is responsible for managing an aggressive national program of applied research, development, demonstration, testing, and evaluation for environmental cleanup, waste management, and related technologies. This Technology Development (TD) Program undertakes a focused problem-oriented approach to have technologies available for use to support DOE's environmental management needs. The TD Program is designed to resolve major technical issues, to rapidly advance beyond current technologies for environmental restoration and waste management operations, and to expedite compliance with applicable environmental laws and regulations.

Appendix I Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW

DOE is characterizing the many types of waste at its facilities. Because information about the waste streams is continually being updated, DOE documents prepared at different times may contain different information on waste inventories and waste disposition. Since the initial preparation of the WM PEIS, DOE has issued updated information on several types of waste. This appendix addresses newly available data on LLW, LLMW, and TRUW; potential impacts on the analyses of alternatives in the WM PEIS; and recommendations for reanalysis where critical to programmatic decision making.

15.2 Technical Reports

Technical reports provide detailed data and other background information developed in support of the WM PEIS and its appendices. These documents were produced as noted below by DOE's National Laboratories or by the contractor (META/Berger) that supported DOE in the development of the WM PEIS. The available documents are listed here, organized into major categories pertinent to the WM PEIS.

Waste Types, Technologies, and Source Terms

Argonne National Laboratory. 1996. *High-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by S.M. Folga, G. Conzelmann, J.L. Gillette, P.H. Kier, and L.A. Poch. ANL/EAD/TM-17. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Low-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by M.L. Goyette and D.A. Dolak. ANL/EAD/TM-20. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Transuranic Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by K.J. Hong, T.J. Kotek, S.M. Folga, B.L. Koebnick, Y. Wang, and C.M. Kaicher. ANL/EAD/TM-22. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Hazardous Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by M.A. Lazaro, A.A. Antonopoulos, M.P. Esposito, and A.J. Policastro. ANL/EAD/TM-25. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *WASTE_MGMT: A Computer Model for Calculation of Waste Loads, Profiles, and Emissions* by T.J. Kotek, H.I. Avci, and B.L. Koebnick. ANL/EAD/TM-30. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Information Related to Low-Level Mixed Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by B.D. Wilkins, D.A. Dolak, Y.Y. Wang, and N.K. Meshkov. ANL/EAD/TM-32. Aug. Argonne, IL.

Los Alamos National Laboratory. 1996. *Mixed-Waste Treatment Model: Basis and Analysis* by Bryon Palmer. LA-13041-M5. Sept. Los Alamos, NM.

Musgrave, B.C. 1995. *Analysis of Waste Treatment Requirements for DOE Mixed Waste - Technical Basis.* Feb. Livermore, CA: BC Musgrave, Inc.

Pacific Northwest Laboratory. 1995. *Description of Source Term Data on Contaminated Sites and Buildings Compiled for the Waste Management Programmatic Environmental Impact Statement (WM PEIS)* by S.M. Short, D.E. Smith, J.G. Hill, and M.E. Lerchen. PNL-10450, AD-940. Sept. Richland, WA.

Treatment, Storage, and Disposal Facility Accidents

Argonne National Laboratory. 1996. *Analysis of Accident Sequences and Source Terms at Waste Treatment and Storage Facilities for Waste Generated by U.S. Department of Energy Waste Management Operations* by C. Mueller, B. Nabelssi, J. Roglans-Ribas, S.M. Folga, and A. Policastro (ANL); W. Freeman, University of Illinois at Chicago; and R. Jackson, S. Turner, and J. Mishima (Science Applications International Corporation). ANL/EAD/TM-29. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Waste_ACC: A Computer Model for Analysis of Waste Management Accidents* by B.K. Nabelssi, S. Folga, E.J. Kohout, C.J. Mueller, and J. Roglans-Ribas. ANL/EAD/TM-52. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Supplemental Analysis of Accident Sequences and Source Terms for Waste Treatment and Storage Operations and Related Facilities for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by S. Folga, C. Mueller, B. Nabelssi, E. Kohout, and J. Mishima. ANL/EAD/TM-53. Aug. Argonne, IL.

Transportation Risk

Argonne National Laboratory. 1996. *Risk Assessment for the On-Site Transportation of Radioactive Wastes for the Department of Energy Waste Management Programmatic Environmental Impact Statement* by B.M. Biwer, F.A. Monette, and S.Y. Chen. ANL/EAD/TM-18. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Risk Assessment for the Off-Site Transportation of High-Level Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by F.A. Monette, B.M. Biwer, and S.Y. Chen. ANL/EAD/TM-21. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Supplemental Information Related to Risk Assessment for the Off-Site Transportation of Low-Level Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by F.A. Monette, B.M. Biwer, D.J. LePoire, and S.Y. Chen. ANL/EAD/TM-23. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Supplemental Information Related to Risk Assessment for the Off-Site Transportation of Transuranic Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by F.A. Monette, B.M. Biwer, D. LePoire, and S.Y. Chen. ANL/EAD/TM-27. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Risk Assessment for Transportation of Hazardous Waste and Hazardous Waste Components of Low-Level Mixed Waste and Transuranic Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by M.A. Lazaro, A.J. Policastro, H.M. Hartmann, A.A. Antonopoulos, D.F. Brown, W.E. Dunn, M.A. Cowen, Y.S. Chang, and B.L. Koebnick. ANL/EAD/TM-28. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Supplemental Information Related to Risk Assessment for the Off-Site Transportation of Low-Level Mixed Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by F.A. Monette, B.M. Biwer, D.J. LePoire, M.A. Lazaro, A.A. Antonopoulos, H.M. Hartmann, A.J. Policastro, and S.Y. Chen. ANL/EAD/TM-35. Aug. Argonne, IL.

Facility Human Health Risk

Oak Ridge National Laboratory. 1995. *DOE Public and Onsite Population Health Risk Evaluation Methodology for Assessing Risks Associated with Environmental Restoration and Waste Management.* ORNL-6832. April. Oak Ridge, TN: Center for Risk Management.

Oak Ridge National Laboratory. 1995. *DOE Worker Health Risk Evaluation Methodology for Assessing Risks Associated with Environmental Restoration and Waste Management*. ORNL-6833. May. Oak Ridge, TN: Center for Risk Management.

Oak Ridge National Laboratory. 1995. *Waste Management Programmatic Environmental Impact Statement Methodology for Estimating Human Health Risks Associated with Waste Management*. ORNL-6864. May. Oak Ridge, TN: Center for Risk Management.

Oak Ridge National Laboratory. 1996. *Supplemental Results of the Human Health Risk Analysis for the U.S. Department of Energy Draft Waste Management Programmatic Environmental Impact Statement*. ORNL-6867. July. Oak Ridge, TN: Center for Risk Management.

Oak Ridge National Laboratory. 1995. *Ecological Risks of the Department of Energy's Programmatic Waste Management Alternatives* prepared by Oak Ridge National Laboratory, Environmental Sciences Division and Advanced Sciences, Incorporated. Aug. Oak Ridge, TN.

Environmental and Socioeconomic Impacts

U.S. Department of Energy. 1996. *Waste Management Environmental and Socioeconomic Impacts Methods and Results* prepared by META/Berger. M/B SR-02. Washington, DC: Office of Environmental Management.

Treatment Alternatives for LLMW

U.S. Department of Energy. 1996. *Impacts from Use of an Alternative Organic Treatment Technology in the Waste Management Programmatic Environmental Impact Statement* prepared by META/Berger. M/B SR-03. Washington, DC: Office of Environmental Management.

Costs

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Mixed Low-Level Waste* by D.E. Shropshire, Michael Sherick, and Chuck Biagi. INEL-95/0014, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Transuranic Waste* by D.E. Shropshire, Michael Sherick, and Chuck Biagi. INEL-95/0015, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Hazardous Waste* by D.E. Shropshire, Michael Sherick, and Chuck Biagi. INEL-95/0016, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Low-Level Waste* by D.E. Shropshire, Michael Sherick, and Chuck Biagi. INEL-95/0013, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1995. *Waste Management Facilities Cost Information for Transportation of Radioactive and Hazardous Materials* by F.H. Feizollahi, D.E. Shropshire, and D. Burton. INEL-95/0300, Rev. 1. June. Idaho Falls, ID.

Idaho National Engineering Laboratory. 1996. *Life-Cycle Costs and FTE for the Department of Energy's Waste Management Programmatic Environmental Impact Statement* by M. J. Sherick and D.E. Shropshire. INEL-95-0127. Idaho Falls, ID.

Affected Environment

Oak Ridge National Laboratory. 1995. *Programmatic Environmental Impact Statement Installation Descriptions*. ORNL-6841. Oak Ridge, TN: Center for Risk Management.

U.S. Department of Energy. 1996. *Technical Report on Affected Environment for the DOE Sites Considered in the DOE Waste Management Programmatic Environmental Impact Statement (WM PEIS)* prepared by META/Berger. M/B SR-01. Washington, DC: Office of Environmental Management.